NOVEMBER/DECEMBER 1995 ISSUE #51

Radio Fun

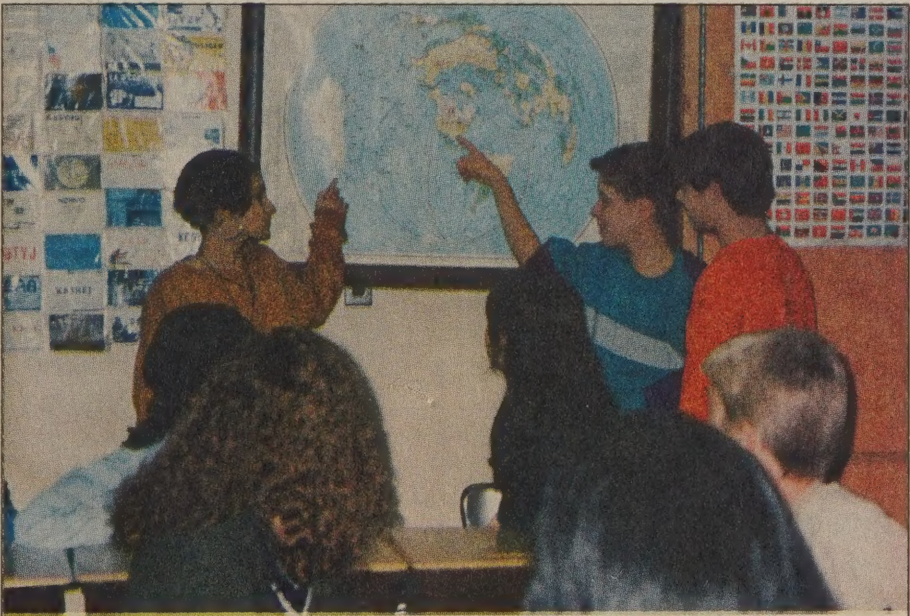
$2.00

"The beginners' guide to the exciting world of amateur radio."

No Code!

UK Government Says Yes to HF No Code

The radio regulatory agency of the United Kingdom says that it will back worldwide no-code licensing for high frequency ham radio operations. Word comes in the form of a notification to the Radio Society of Great Britain from the United Kingdom Radiocommunications Agency, the British equivalent of our FCC. According to the RSGB, and as reported last week here on Newsline, the New Zealand government is to propose the abolition of the international requirement for radio amateurs to pass a Morse test. This, prior to being permitted to use the HF bands. The RSGB says that it now understands that the government of United Kingdom intends to support this proposition. The Society says that it has protested to the Radiocommunications Agency the government decision to support New Zealand. RSGB contends that it runs contrary to the views of UK radio amateurs expressed in a survey carried out by the Society in 1993. The RSGB says that the governments pro code-free position also appears to ignore the policy of all three regions of the International Amateur Radio Union. But it now appears as if several of the world's most prominent governments care very little about what the current ham radio community wants. Both New Zealand and now the United Kingdom are telling their hams that, whether they like it or not, no-code is a way whose time has come. *TNX Newsline.*



It's more fun to have a geography lesson when ham radio is involved. Notice all the QSL cards to the left of the map. *Turn to page 23 for the rest of the story* *which tell how the 50 states got their nicknames.*

IN THIS ISSUE

FEATURES

REVIEW

DEPARTMENTS

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ASTRON POWER SUPPLIES

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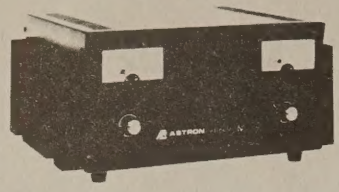

MODEL VS-50M

SPECIAL FEATURES

- SOLID STATE ELECTRONICALLY REGULATED
- FOLD-BACK CURRENT LIMITING Protects Power Supply from excessive current & continuous shorted output
- CROWBAR OVER VOLTAGE PROTECTION on all Models except RS-3A, RS-4A, RS-5A, RS-4L, RS-5L
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- THREE CONDUCTOR POWER CORD except for RS-3A
- ONE YEAR WARRANTY • MADE IN U.S.A.

PERFORMANCE SPECIFICATIONS

- INPUT VOLTAGE: 105-125 VAC
- OUTPUT VOLTAGE: 13.8 VDC ± 0.05 volts (Internally Adjustable: 11-15 VDC)
- RIPPLE Less than 5mv peak to peak (full load & low line)
- All units available in 220 VAC input voltage (except for SL-11A)

SL SERIES

• LOW PROFILE POWER SUPPLY

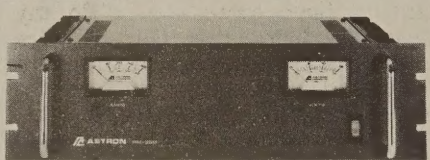
MODEL	Colors Gray	Colors Black	Continuous Duty (Amps)	ICS* (Amps)	Size (IN) H × W × D	Shipping Wt. (lbs.)
SL-11A	•	•	7	11	2⅝ × 7⅝ × 9¾	12
SL-11R	•	•	7	11	2⅝ × 7 × 9¾	12
SL-11S	•	•	7	11	2⅝ × 7⅝ × 9¾	12
SL-11R-RA		•	7	11	4¾ × 7 × 9¾	13

RS-L SERIES

• POWER SUPPLIES WITH BUILT IN CIGARETTE LIGHTER RECEPTACLE

MODEL	Continuous Duty (Amps)	ICS* (Amps)	Size (IN) H × W × D	Shipping Wt. (lbs.)
RS-4L	3	4	3½ × 6⅛ × 7¼	6
RS-5L	4	5	3½ × 6⅛ × 7¼	7

RM SERIES

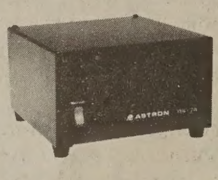


MODEL RM-35M

• 19″ RACK MOUNT POWER SUPPLIES

MODEL	Continuous Duty (Amps)	ICS* (Amps)	Size (IN) H × W × D	Shipping Wt. (lbs.)
RM-12A	9	12	5¼ × 19 × 8¼	16
RM-35A	25	35	5¼ × 19 × 12½	38
RM-50A	37	50	5¼ × 19 × 12½	50
RM-60A	50	55	7 × 19 × 12½	60
• Separate Volt and Amp Meters				
RM-12M	9	12	5¼ × 19 × 8¼	16
RM-35M	25	35	5¼ × 19 × 12½	38
RM-50M	37	50	5¼ × 19 × 12½	50
RM-60M	50	55	7 × 19 × 12½	60

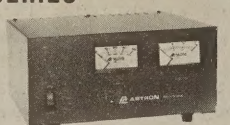
RS-A SERIES



MODEL RS-7A

MODEL	Colors Gray	Colors Black	Continuous Duty (Amps)	ICS* (Amps)	Size (IN) H × W × D	Shipping Wt. (lbs.)
RS-3A		•	2.5	3	3 × 4¾ × 5¾	4
RS-4A	•	•	3	4	3¾ × 6½ × 9	5
RS-5A		•	4	5	3½ × 6⅛ × 7¼	7
RS-7A	•	•	5	7	3¾ × 6½ × 9	9
RS-7B	•	•	5	7	4 × 7½ × 10¾	10
RS-10A	•	•	7.5	10	4 × 7½ × 10¾	11
RS-12A	•	•	9	12	4½ × 8 × 9	13
RS-12B		•	9	12	4 × 7½ × 10¾	13
RS-20A	•	•	16	20	5 × 9 × 10½	18
RS-35A	•	•	25	35	5 × 11 × 11	27
RS-50A	•		37	50	6 × 13¾ × 11	46
RS-70A	•		57	70	6 × 13¾ × 12⅛	48

RS-M SERIES



MODEL RS-35M

MODEL	Continuous Duty (Amps)	ICS* (Amps)	Size (IN) H × W × D	Shipping Wt. (lbs.)
• Switchable volt and Amp meter				
RS-12M	9	12	4½ × 8 × 9	13
• Separate volt and Amp meters				
RS-20M	16	20	5 × 9 × 10½	18
RS-35M	25	35	5 × 11 × 11	27
RS-50M	37	50	6 × 13¾ × 11	46
RS-70M	57	70	6 × 13¾ × 12⅛	48

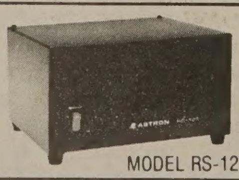
VS-M AND VRM-M SERIES

MODEL VS-35M

• Separate Volt and Amp Meters • Output Voltage adjustable from 2-15 volts • Current limit adjustable from 1.5 amps to Full Load

MODEL	Continuous Duty (Amps) @13.8VDC	@10VDC	@5VDC	ICS* (Amps) @13.8V	Size (IN) H × W × D	Shipping Wt. (lbs.)
VS-12M	9	5	2	12	4½ × 8 × 9	13
VS-20M	16	9	4	20	5 × 9 × 10½	20
VS-35M	25	15	7	35	5 × 11 × 11	29
VS-50M	37	22	10	50	6 × 13¾ × 11	46
VS-70M	57	34	16	70	6x13¼ x 12⅛	48
• Variable rack mount power supplies						
VRM-35M	25	15	7	35	5¼ × 19 × 12½	38
VRM-50M	37	22	10	50	5¼ × 19 × 12½	50

RS-S SERIES



MODEL RS-12S

• Built in speaker

MODEL	Colors Gray	Colors Black	Continuous Duty (Amps)	ICS* Amps	Size (IN) H × W × D	Shipping Wt. (lbs.)
RS-7S	•	•	5	7	4 × 7½ × 10¾	10
RS-10S	•	•	7.5	10	4 × 7½ × 10¾	12
RS-12S	•	•	9	12	4½ × 8 × 9	13
RS-20S	•	•	16	20	5 × 9 × 10½	18
SL-11S	•	•	7	11	2¾ x 7⅝ x 9¾	12

*ICS—Intermittent Communication Service (50% Duty Cycle 5min. on 5 min. off)

CIRCLE 16 ON READER SERVICE CARD

Welcome Newcomers

by Wayne Green W2NSD/1

Here's The Deal...

If you're a new licensee, you'll be getting two sample copies of *Radio Fun*. The purpose of the publication is to encourage newcomers to find out how easy it is to explore all of the fun things there are to do in amateur radio. Hamming is really 73 different hobbies, ranging from DXing, going on DXpeditions, packet, repeaters, communicating via our couple of dozen ham satellites, slow-scan TV, fast-scan TV, traffic handling, nets, fox hunting, club work, RTTY, AMTOR, CW, certificate hunting, contests, elmering, and on and on. You need the monthly shot of excitement this magazine provides, so send me $12.95 for a year's worth of shots. It's one of the best ham investments you can make. Heck, the theory series we're publishing, which will help you understand the basics instead of just memorizing Q&A answers, will be worth more than that to you.

Send your check or credit card information to *Radio Fun*, 70 Route 202N, Peterborough NH 03458. Or call 800-274-7373 with your credit card number. Please do this right away instead of letting this sit in a pile somewhere of things you intend to do.

In addition to some corking good columns, the K2OAW tech series, new product reviews, and some simple construction projects, you'll be reading my editorials. They go on for three and four pages of small type on *73*, but this is a smaller magazine, so I usually make do with one page. In my editorials I write about almost anything I think will (or should) interest you. This comes from what is probably a genetic defect which makes me want to share with you anything which I particularly enjoy. Heck, that's what got me into publishing in the first place. It all started when I found out how much fun RTTY was back in 1949. I had a ball with it and wanted to let other hams know how much fun they were missing, so I started my first magazine in 1951.

That led to a column in *CQ*, which led to me becoming the editor for five years. When they got to where they owed me a year's pay they fired me, so I had to start my own magazine. That was 1960, when I started *73*.

I then went on to help pioneer sideband, 2m FM and repeaters, SSTV, computers, and so on, with the ARRL busy fighting these new technologies just about every inch of the way. Yes, I've been an ARRL member almost 60 years now, but I don't think they're going to elect me president. I'm too controversial.

I read a lot and have a wide variety of interests. When I find a book I think you'll really enjoy, I write about it. I encourage my readers to let me know of any books they think are really worth reading, or any fantastic music I may have missed. They send me newspaper and magazine clippings about just about everything: UFOs, contactees, educational reform, health care alternatives, psychics, travel, cooking, submarines, flying, and so on.

> "only my magazines cover everything in the hobby, and give you the straight dope"

For instance, I'm reading a new book on ancient civilizations which mentions the Piri Reis map, which was copied in 1531 from much older maps. When I first read about this map 22 years ago I went to visit Father Linehan W1HWK, the head of the Weston Observatory, who was an expert on this map. He told me about the expeditions he went on to verify its accuracy. I wrote in *73* about this at the time, and I'll be writing again. The map shows the eastern coasts of North and South America, but most amazingly it shows Antarctica and Greenland accurately as they were before they had ice caps, and thus it relied on source maps that had to be over 10,000 years old. The map projection is from a point in space over the Great Pyramid of Giza!

I also write a lot about amateur radio, both the good and the bad. I have plenty of supporters and some detractors. But I've never met a detractor who has shown any sign of thinking for himself. My editorials are aimed at getting people to think, and to have more fun. I do my homework before I write, so I always ask anyone disagreeing with me to let me know why, and to give me any data I might have missed.

When the compact disc came along 12 years ago, I decided to try and help this new technology grow. I helped with magazines, a digital recording studio, and several record labels of my own. When cold fusion began to look like more than a laboratory curiosity I started a magazine last year to help that new field turn into an industry.

I keep trying to get as many readers as possible to start their own businesses, because that's where the real money is, and it's much more fun to have your own business than to work for someone else.

So let's get you going in amateur radio with *Radio Fun*, and then I'll get you to read *73*, which has even more reviews of new ham gear, tons of antenna articles, simple construction projects, and so on. You can read *QST* and get your League news, and *CQ*, if you're into contests. But only my magazines cover everything in the hobby, and give you the straight dope on what's going on.

Give my 800 number a call and let's get started. If you want, we can start your subscription with issue #49, which is the start of the K2OAW basics of electronics series, which will be going on for a year or more. Until we run out, anyway. *73* is $24.95/year. The two together, special, $35. RF

Letters

Write to: Radio Fun, 70 Route 202-N, Peterborough, NH 03458

Mike Snowden KE6HVH I am a "newbie" to amateur radio, just over a year now. Since I have started reading his ham radio magazines, Wayne has reminded me that there is more to amateur radio than slapping down a credit card to buy amateur radio gear. He reminded me of my father K6YPB, now a silent key, who was forever burning up the solder when I was a kid. He was always building something. I only wish it had not taken me 37 years to discover those same joys.

I do not have the electronic education he and others have, so I am like a new born, learning as I go. I joined a radio club in hopes to get "educated," but as it turns out, most have the same void as I do. Wayne taught me to quit sitting back and waiting for others. I had done some reading, and picked a topic of interest to the members and began to learn. I have put together two antenna-building parties and the next will be a soldering party. I have never experienced the type of satisfaction I get by helping others to build a project with their hands, and them being able to see and use the fruits of their labor. It is a wonderful feeling. Thank you Wayne.

Ted Brattstrom NH6YK/KC6YK **Just b**ack from Palau and got caught up with the last few months of *73* and *Radio Fun*. OK, I'll attempt some articles for you on the joy of satellites and mini-DXpeditions (KC6YK—NH6YK/KH4—NH6YK/Kalawao County—NH6YK/ZL). However, I'd like to make one complaint, you've been bashing Techs lately and suggesting that they are not full members in the ham community since they are not operating on HF. Granted, many people stop at 2 meter repeaters (others seem to have stopped at 75m or 40m phone . . .), *but* some of us use the satellites and not only work some great DX, but also have had some very interesting conversations.

Of course the other modes are also fun. I've operated packet, TCP/IP, 6m, RS-10, AO-21, FO-20, RS-15, MIR, a bunch of shuttles (packet and voice for both spacecraft types), AO-10, AO-13. So the thing to do is to kick them into really using the spectrum they/we have access to. Granted, HF is fun too! As a Tech+ I've played on 10m phone and received my DXCC, but I've also had some great chats, such as an hour and a half with Trent Christian on Pitcairn. The path to North America closed for him, but he Hawaii, and we kept finding things to talk about. Then again, I've had exciting, if short, 10-minute chats with U5MIR, U3MIR, and Norm Thaggard (RØMIR). It doesn't take high power if there aren't other hams trying to contact them! And I've helped set up a SAREX contact with students from my school and another school. We had lots of fun with that! We simulcast it on the statewide RACES linked repeater system. Some hams and SWL (VHFLs?) got their first taste of space communications listening in! (Hmmm, do you want an article on that?)

Alas, in almost five years of hamming, I've only convinced about 12 people to get their licenses. I ought to be getting way more than that since I am a high school chemistry teacher. But I definitely have added an awareness of radio to my students and colleagues. I'll have to grab that list of ham activities you wrote about and see how I do. I know I haven't worked DXCC in a weekend or done EME/ATV/Aurora, but I've been working at EME, and we are too far south for aurora, and drat, I'm always overseas playing when the Hawaii to West Coast duct is open.

I wasn't too active in Palau this summer. The kayaking, diving, and snorkeling were fine, but the bands weren't in good shape. I operated 20M SSB and RTTY (my privileges in Palau are better than in the US!) as well as OSCAR 10 and 13. It was depressing to hear European stations calling CQ at S5 levels on 20M and then not to be heard by them. At least I made a few contacts with South America.

Ted, we've got 250,000 Techs and they're not going for their General Class licenses, so I'm going to keep right on bashing until I see some results.

Sure, the code is a nuisance, but we've got kids seven years old with their Extra Class tickets, so unless someone is seriously mentally challenged (as they put it these days), they can learn the damned code.

Wayne

continued on page 11

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Communications Simplified, Part 3

by Peter A. Stark K2OAW

So far, parts 1 and 2 have dealt with audio and video signals, respectively. Both of these have dealt with analog waveforms. In this part we discuss digital signals.

Digital Data

In its simplest form, digital data is simply a series of numbers. Those numbers could simply be data (such as some company's payroll records), or they could be a digitized analog signal (such as a digitized telephone signal.) As far as sending those numbers from one place to another, it doesn't really matter what these numbers represent, so we won't worry about that at this point.

Although we humans generally use decimal numbers, both computers and communications equipment use binary numbers. The most important reason is that these numbers are less likely to be misread as errors.

Suppose someone asked you to count the beans in a jar, but specified that you are not allowed to use any number that has a 2, 3, 4, 5, 6, 7, 8, or 9 in it; only numbers with a 0 or a 1 are allowed. How would you count?

Like any good computer person, you'd start with zero, and count

0
1

But now you realize you're not allowed to use anything from 2 through 9, and so you skip ahead to

10
11

Now you're stuck again. You can't write down 12, 13, or even 20 or 30 or 90, so you skip ahead to

100
101

Now you again have to skip ahead to

110
111

and now you must skip a whole series of numbers until you get to

1000
1001

and so on.

Congratulations. In writing down the numbers

0
1
10
11
100
101
110
111
1000
1001
1010

you have just invented the *binary number system*. Each of the counts in this table corresponds to one of the numbers of our decimal number system, as shown in Table 1.

Table 3-1

Binary	Decimal
0	0
1	1
10	2
11	3
100	4
101	5
110	6
111	7
1000	8
1001	9
1010	10

The decimal number system (from the prefix *deci*, which means 10) has ten different digits, whereas the binary number system (from the prefix *bi*, which means 2) has only two. These two binary digits are called *bits*.

Binary numbers are used because, with just two different digits, it's less likely that they will be confused. For example, in a typical digital circuit, the 0 bit might be something "near" 0 volts, while the 1 bit might be something "near" 3 or 5 volts. As long as the 0 voltage doesn't get too big, or the 1 doesn't get too small, circuitry can still reliably tell the difference between them. If you tried to represent decimal digits with voltages, it might be too difficult to tell the difference between one digit and another if the voltage changed a bit as it travels from one place to another.

DETOUR

There was a very fast swing to the use of digital circuitry back in the 1960s and '70s, when digital integrated circuits (ICs) became cheap enough for common use. The most common digital ICs were called Transistor-Transistor Logic, or TTL.

TTL ICs work on two different voltage levels. Anything between 0 and 0.8 volts is one voltage level, while the other is anything between 2.0 and 5.0 volts. Many users call the near-zero voltage level a 0, and the 3–5-volt level a 1. But this is a bad practice, because many designers use the near-zero voltage to stand for a 1, and the 3–5-volt level be a digital 0 signal, which happens to be the exact opposite. (And many designers even switch back and forth between the two systems, sometimes just a few tenths of an inch apart in a circuit.)

To stay out of trouble, don't use the terms "zero" and "one" to refer to digital signals. Instead, call the 0 to 0.8-volt level a *low*, and call the 3–5-volt level a *high*. This is always safer.

TTL voltage levels are still common today; even though many ICs are no longer TTL, they still usually use the same voltage levels.

Incidentally, the words high and low can be used with other voltages as well. For instance, a high might be +15 volts, while a low might be -10. The only thing required is that the high voltage really be higher than the low.

END OF DETOUR

Although the numbers in Table 1 are all different lengths, note that the value of a number doesn't change if you put extra zeroes in front of it. In decimal, for example, 7, 007, and even 00000007 all have the same value. In computers, binary numbers are often stored in

groups of eight bits, called a *byte*. Thus the binary equivalent of a 7 would usually appear as 00000111, rather than just 111.

Looking at Table 1 again, we note that, if you were limited to one-bit-long numbers, you could only express two different ones: 0 and 1. If you used two-bit-long numbers, then you could express four different numbers: 00, 01, 10, and 11, which correspond to the decimal numbers 0, 1, 2, and 3. Likewise, a three-bit number can have eight different values, which correspond to the decimal numbers 0 through 7. We can generalize this rule as follows: a number with n bits can have 2^n different values, corresponding to the decimal numbers from 0 through $2^n -1$. For example, an eight-bit byte can have 28 or 256 different values, which correspond to the decimal numbers from 0 through 255.

A typical byte in a computer could represent one of three things:

A number, or part of a number, used in some computation,

An instruction, or part of an instruction, telling a computer what to do, or

A letter, number, or punctuation mark, coded in ASCII (which stands for the American Standard Code for Information Interchange). These are often called *alphanumeric characters*, or just *characters*.

Serial and Parallel Data Transfer

When binary data is moved from place to place, it is most often moved in bytes. A byte can be transferred from place to place in one of two ways:

Parallel transfer: all eight bits of a byte move at the same time along eight separate wires.

Serial transfer: the eight bits travel on one wire, but in sequence ("serially"), one after another.

Actually, parallel data transfer requires more than eight wires. For example, the most common parallel connection is from a PC computer to a printer; this connection usually involves a 25-pin connector and cable:

8 wires carry the eight bits of data

1 wire carries the data-ready strobe, a signal that tells the printer that a byte is ready

1 wire carries a data-received signal from the printer back to the computer

1 wire carries an out-of-paper signal from the printer back to the computer

1 wire carries a busy signal telling the computer that the printer is busy

1 wire carries a ready signal, telling the computer that the printer is on-line and ready to receive data.

12 wires connect the grounds of the computer and printer together.

The data-ready, data-received, out-of-paper, busy, and ready signals are often called *handshaking* signals because they allow the computer and printer to agree on when and how fast to send data. The reason for twelve ground wires is that the printer connection is often done with a ribbon cable; in order to prevent interaction between closely-spaced adjacent wires, the 13 signal wires are separated by 12 ground wires.

A parallel connection can be quite fast since (1) all bits travel simultaneously, and (2) the handshaking signals allow the computer and printer to communicate at their maximum speed, yet still slow down if one falls behind. On the other hand, the parallel connection requires a lot more wires (even if you cut it down to the bare minimum number of wires needed). Hence parallel connections are only used for short distances.

All long-distance data transfer is therefore done through serial connections. In these, all data bits as well as some simplified handshaking signals travel along one wire (although there is also at least one additional ground or return wire).

RS-232 and Asynchronous Serial

The most common serial connection is known as RS-232. Although it also often uses either a 25-pin or 9-pin connector, only two wires are absolutely necessary in an RS-232 connection: one for signal, the other for ground.

For example, the ASCII code for the lower case letter *a* in a personal computer is 01100001. If you looked at the letter *a* carried on an RS-232 signal wire, with an oscilloscope, you would see the waveform in Figure 1.

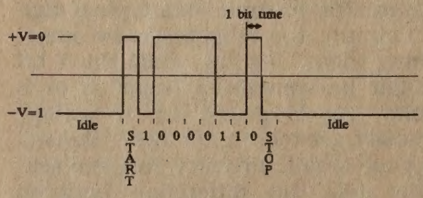


Fig. 1. A serial RS-232 letter "a".

First, you note that although the code is 01100001, the bits shown in the figure are 10000110, which is backward. That is because they really *are* sent backward. The rightmost 1 (at the end of 01100001) is called the *least significant digit* or *lsd*, and is sent first; the leftmost, called the *most significant digit* or *msd*, is sent last. There is a historical reason for this, which we'll see in a moment.

Next, you will note that a 1 is a negative voltage, labeled as -V in Figure 1, while the 0 is a positive voltage labeled +V. The precise voltages are not specified, and could be anything from 3 volts up to 15 volts. Hence, in one system the voltages might be -5 and +5 volts, while in another they might be -12 and +10, or whatever.

There is room for some confusion here, since many people wrongly think that a 1 has to be more positive than a 0, which of course is not the case here. To avoid that problem, many communications people therefore call the 1 signal a *mark*, while the 0 signal is called a *space*. (To use our earlier terminology, a the mark or 1 signal is the low here, while the space or 0 signal is high.)

At the top of Figure 1 is the notation "1 bit time" which shows the length of one bit. Within the byte, each bit has exactly the same length, which we call a *bit time*. The string of four zeroes in the middle, for example, is exactly four bit times long. Both the sender and the receiver must agree on the exact length of a bit so that, when a string of ones or zeroes arrives, the receiver can determine exactly how many bits there are in that string.

Once we know the length of one bit, we can calculate the maximum number of bits per second. For example, if each bit is 1/300 second, there could be a maximum 300 such bits sent per second. Thus the *bit-per-second* or *bps* rate is defined as

bits-per-second = 1/(1 bit time)

Since both the sender and receiver have to agree on the bit-time (and therefore the bps rate), there are certain bps rates which have become standardized over the years. These are 300, 600, 1200, 2400, 4800, 9600, etc. You can see the pattern in these. Incidentally, you often see the bps or bit-per-second rate referred to as the *baud rate*. This is not entirely right, since baud rate has a different meaning from bps; still, it's a common use, and we might as well live with it. (When we get to discuss modems, we will see what the difference is.)

Although the timing of the bits within a character is very exact, the timing between characters is not. For instance, if the signal is coming from a keyboard, there might be long spaces between characters as the typist is searching for the next key. For that reason, this kind of serial data transmission is called *asynchronous*, meaning not synchronized. The bits are carefully timed (synchronized to a clock), but the characters are not.

Thus there has to be a way of telling the receiver when there is nothing being sent, and when the next character begins. The "nothing is being sent" condition is called an *idle*, shown as a 1 or mark signal in Figure 1. Note that there can also be a 1 or mark signal inside a character, but that will generally be shorter.

The "character is starting" code is called a *start pulse*, and is always a 0, or space, which follows the idle. Thus a long mark (1) followed by a space (0) pulse marks the beginning of a character.

Since the sender and receiver will always agree beforehand on the number of bits in the character (usually eight), they can count bits from the start pulse and figure out when the character is over. Hence they don't really need a stop signal. Nevertheless, there is always a *stop pulse* sent at the end, which is always a 1. This is another of those historical things, dating back to when mechanical distributors (much like the distributor in a car) were used to convert to and from serial data in teletype machines. These distributors were run by a motor, and a clutch needed time to start and stop the distributor for every character. In fact, these systems often needed extra time, and so the stop pulse was extra long. We still sometimes hear of "two stop pulses," which really just means a stop pulse of double the normal length.

When serial data is sent slowly, such as from a keyboard, the stop pulse is usually followed by another idle signal of some unknown length. But when the data comes from a computer, it can come at maximum speed. In that case, the stop pulse might be immediately followed by another start pulse, with no idle between them. If you start watching such a data stream in the middle, things can get somewhat confusing since you can't tell which zeroes are start pulses, and which zeroes are data bits. To be really sure, you have to go back to the last previous idle time, and start counting bits from there. Computers also often get confused—if you temporarily break the connection in a serial line you mess up the timing, and all the following data may be wrong until things slow down and the next idle reestablishes synchronization.

In any case, we now see that an eight-bit byte sent on a serial line actually takes a total of ten bits. The addition of the two start and stop bits adds a 25% *overhead* which slows down the transmission. (Hence computer-to-computer data transmission often uses *synchronous* transfer, which doesn't waste as many bits.)

Parity

Let's return to ASCII for a moment. As mentioned earlier, ASCII is a code for encoding letters, numbers, and punctuation marks into binary bits. Although we earlier said that the code for the letter *a* is 01100001, that's not quite true. The true ASCII code is just seven bits, and so it's really just the seven bits 1100001. So where does that eighth bit come from?

Since computer memory locations (at least, those of smaller computers) come in eight-bit bytes, there is an extra bit left over when storing a seven-bit ASCII character in such a memory location. This extra bit can be treated in several ways.

It can be left unused. But since you can't just leave the bit empty, you must put something into it. Hence you could routinely just force it to be a 0 or a 1. In this case, the letter *a* could be stored as 01100001 in some computers, and 11100001 in others.

It can be used to increase the number of available characters. For instance, in PC-clone computers, this extra bit is a 0 for all normal characters, but becomes a 1 for special characters. For example, 01100001 in such a computer is still an *a*, but 11100001 is used to store the Greek letter ß This allows the computer to use an extended character set which includes symbols like ±, π, √, ≥ and °, which are not in the regular ASCII code. This code is sometimes called *extended ASCII*.

It can be used for *parity* error checking. This is not usually done in small computers, where errors tend to be rare, because signals travel shorter distances or because other methods are used to check and correct errors. But parity checking is common when data travels a long distance.

Parity comes in two types—*even parity* and *odd parity*. In even parity, the eighth bit is chosen so that the total number of ones in the character is even; in odd parity it is made odd. For instance, the ASCII code for *a* is 1100001, which has an odd number of ones. For even parity, an extra 1 would be added so that the total number of ones in 11100001 is even; in odd parity the extra bit would be 0 to keep the odd number of ones in 01100001. Another example is the capital letter A, whose ASCII code is 1000001. This would become 01000001 in even parity, and 11000001 in odd parity.

If you've ever seen abbreviations like 8N1 or 7E1, now you can understand what this means:

8N1 means eight data bits with No parity bit, and one stop pulse.

7E1 means seven data bits plus an Even parity bit, and one stop pulse.

Note that the circuitry can't generate or check a parity bit until it has the remaining seven bits of the character. This is the reason why each byte in an RS-232 serial line is sent backward—to put the parity bit at the end, after all the previous data bits.

Error correction and error detection

The idea behind using parity is that every character sent has a specific 0 or 1 bit in that eighth or parity position, determined by the rest of the bits. If any one of the bits in that group somehow gets changed due to an error in transmission, the number of ones will add up to the wrong number, and the receiver can detect that an error has occurred. But note that if two bits (or any even number of bits) get changed, the error can't be detected. For instance, if the 01100001 for an odd-parity *a* gets changed to 01100111, the number of ones is still odd, but the *a* was changed to a *g* without the receiver being able to detect a parity change. The reason is that with just one parity bit, the chance of an error occurring but the parity still accidentally being right are 50%.

Detecting, and even possibly correcting, errors in digital data is important, because an error in just one bit can make a huge error. Hence the parity bit is a useful step, but not enough.

There are a number of ways of handling errors. The most important step is to be able to detect them, because once you know an error has occurred, you can take

steps to fix it. One way is to increase the number of parity bits to reduce the chances of an error going by unnoticed; in this case these bits are usually just called error-detection bits, rather than parity bits.

One common way to do this is to generate a CRC or *Cyclic Redundancy Check* number with a CRC generator. The CRC generator is basically a number of computer building blocks called *flip-flops* (usually 16, although more or fewer can be used), which are interconnected using additional computer components called *gates*.

The flip-flops are computer circuits which can store either a 0 or a 1 bit. Initially, all the flip-flops are set to hold a 0, and then the outgoing string of bits in the sender is passed through the chain of flip-flops. After all the bits pass through, some of the flip-flops wind up holding a 0, while others hold a 1. The precise bit pattern in the flip-flops depends on what data went through and how they are interconnected. If there are 16 flip-flops, then they wind up holding a 16-bit number called the CRC, which is then sent after the data as an extra set of bits.

In the receiver, an identical CRC generator circuit receives the data, and also generates its own CRC. If there was no error, the CRC sent by the sender should therefore be identical to the CRC generated in the receiver. If they are different, then an error occurred somewhere along the way.

When 16 flip-flops are used to generate a 16-bit CRC, the CRC number itself could have any one of 2^{16}, or 65,536 different values. When an error occurs, there is only 1 chance out of 65,536 that the resulting CRC will accidentally be the same as the correct CRC that was generated by the sender. This means that only 1 out of 65,536 errors is likely to sneak through without being caught; in other words, 65,535 times out of 65,536 the error will be detected, which means that the data has a 99.998% chance of being correct. That's a lot better than the 50% chance with just a single parity bit!

Even with just an 8-bit CRC which has 256 possible values, there is a 255 out of 256 probability, or 99.6% of an error being detected.

When an error is detected, how do you correct it? There are two ways: *backward error correction*, and *forward error correction*.

In backward error correction, when the receiver detects an error it asks the sender to transmit the data again. Forward error correction involves sending enough extra (called *redundant*) bits right away so that the receiver can correct an error without asking for a retransmission.

Backward error correction is fairly straightforward. It's what we use every day when we say to someone, "Huh? What was that? Say it again?" The only catch with it is that we need what is called a *reverse signal path*; that is, we need some way of getting a message from the receiver back to the sender. In many communications methods there is a two-way path, so it's easy to get that message back to the sender; sometimes, though, that reverse path may not be present. For example, if a sender (such as a pager transmitter) sends a signal to many different receivers (such as pagers), it's not practical for each receiver to be able to reply to the sender.

Even in simple cases, sending a reverse message asking for a correction takes extra time. Thus backward error correction is more useful if there are relatively few errors so you don't have to ask for too many repeats.

Forward error correction is more interesting, and more difficult. It uses a class of *error correcting codes* or ECC which have built-in redundancy.

Redundancy means including more information than really necessary. For example, the English language has a lot of redundancy, because you can often remove a lot of letters from a message without losing essential information. Consider the sentence "Ths sentins has a lutt of errurs." Even though there are missing letters, extra letters, and even some wrong letters, you know what it says. That's because of redundancy.

The same can be built into computer messages. As a really simple example (since most ECC codes can be quite complex), consider what is called *longitudinal parity*. Let's say you send the word Help in ASCII with even parity:

H = 01001000
e = 01100101
l = 01101100
p = 11110000

so the message reads

01001000
01100101
01101100
11110000

If one single bit somewhere in the four bytes gets changed, you can detect the error and you know which *letter* is wrong, but you cannot correct it because you don't know which *bit* of the eight in that letter is wrong. But suppose you add an additional set of even parity bits, called longitudinal parity, going down the list, like this:

01001000
01100101
01101100
11110000
10110101

The fifth group of bits has been chosen so that *the number of ones reading down any column is also even*. Now suppose an error occurs so *one* of the bits somewhere gets changed, such as the fourth bit in the third row, which got changed from a 0 to a 1:

01001000
01100101
01111100
11110000
10110101

As a result, the third row now has the wrong parity because it has an odd number of ones; the fourth column now also has the wrong parity. We therefore know that the error is in the third row and fourth column, and so we can change the bit in that position from a 1 back to a 0.

This kind of error checking can detect and correct a single bit error, and can detect (but not always fix) a two-bit error. That isn't good enough for most communications applications, because quite often noise bursts and other problems cause an entire series of bits to be wiped out. Hence more sophisticated error correction methods are used, but other than knowing about them, we need not really study them further at this point.

Synchronous Serial Data Transfer

The asynchronous serial method we've discussed so far has the advantage of being simple, but it also has a number of disadvantages. The primary one is that it is inefficient—not only are there two overhead bits for every eight data bits (which wastes time), but the parity bit (if used) adds still another wasted bit that doesn't really do a good enough job of detecting errors. Synchronous data transmission is a way around that. But because it is more complicated, it is generally only used in high-speed applications, such as when two computers are communicating directly with each other. You will seldom see it in a home or small office PC.

In the synchronous method, many bytes of data (usually some power of 2, such as 128 or 256) are sent, one right after another, with-

out separating them by stop and start bits. But now timing becomes very important because a very large number of bits is sent in arow, and even a slight error in timing them could cause a miscount. Error detection is also important, because in a long string of bits there is a greater probability of something going wrong. Synchronous data transmission therefore usually works something like this:

"There is never enough bandwidth, always a bit too much distortion, always a bit too much noise."

When there is nothing to send, the sender sends an idle signal. What this is depends on whether there is only one sender on the line, or whether the same line might be used by several senders. If there might be multiple senders, then the idle is nothing—not mark or space, but literally nothing—an open connection. If there is only one sender, then the idle is more likely to be a continuous string of bits rather than a continuous mark or 1 signal. For example, the system might send a continuous string of 01010101... bits.

To signal the start of data, the sender sends a different series of easily recognizable bits, instead of a start pulse as in asynchronous data. For example, the sequence 00111100 or 10010110 might be used; both of these are sufficiently different from the idle to be easily recognized as something new.

Next comes the data, generally as a fixed-length group of bytes. Typically there might be 128 or 256 bytes, though it might be some other power of 2.

After the data would come a CRC, usually a 16-bit number, which provides a fairly good probability of detecting errors. The CRC might be followed by another short idle signal, or there might be another start sequence.

Back to bandwidth

In previous parts, we discussed the bandwidth needed for audio and video signals. What about the bandwidth for digital data?

Although digital signals don't exactly consist of square waves, they look close enough to square waves that we suspect that there are a lot of harmonics. Although we haven't specifically said so before, a general rule of thumb is that the faster signals change—the more kinks and corners they have—the higher the frequencies in that signal. This almost certainly means that there will be a lot of harmonics, and so it implies that we need lots of bandwidth.

That is generally true; fortunately it's not as bad as it seems. As we mentioned earlier, the reason that binary numbers are used instead of decimal numbers is that it is easier to tell the difference between a 0 bit and a 1 bit than to have to tell the difference between ten different digits. Even if a digital signal gets all distorted, it may still be possible to read it without errors as long as the ones and zeroes do not get totally confused with each other.

For example, Figure 2 shows a "before" and "after" comparison of a digital signal that went through a communications circuit whose bandwidth was too low, so that many of the harmonics were reduced or eliminated. This much distortion on an audio or video signal might be disastrous; yet the digital signal can be recovered from the "after" signal with fairly simple circuitry. The timing will be slightly changed, but even that can be fixed. As a result, the digital data would go through this system without major errors.

Let's keep in mind that there is no such thing as a perfect communications circuit. There is never enough bandwidth, always a bit too much distortion, always a bit too much noise. These will always affect an audio or video signal in some way; in fact, they will affect all analog signals, and once some noise or distortion affects an analog signal, it is almost impossible to clean it up again.

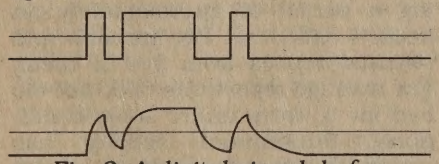


Fig. 2. A digital signal, before and after distortion.

Digital signals, however, behave differently. As long as the 0 and 1 bits are recognizable, they can usually be recovered and the original digital data will come through without change. And once recovered, that same data can be sent once again through another circuit. Thus, as long as you *regenerate* the data often enough, you can send it as far as you'd like without its being corrupted. This is one big advantage of digital data transmission over analog data.

Claude Shannon, a Bell Laboratories mathematician, calculated back in 1948 the absolute maximum theoretical number of bits that can be sent through a communications circuit in one second as

$$\text{max bps} = BW \log_2 (S/N + 1)$$

where BW is the bandwidth, and S/N is the signal-to-noise ratio—the ratio between the signal power and the noise power.

Mathematicians call the expression $\log_2$ in this equation the "logarithm base 2." Calculating it is somewhat difficult, so for a good approximation let's think of it simply as the number of bits needed to represent the value of $(S/N + 1)$. For example, let's consider a telephone line with a bandwidth of 3000 Hz, and suppose the power of a telephone signal is 30 times higher than the power of the noise, so $S/N = 30$. We need 5 bits to represent the number 31 (which is 30 + 1), so the theoretical maximum number of bits per second in a telephone connection would be 3000 times 5, or 15,000 bps. (With modern telephone lines, and with some tricks to compress data, it is possible to go somewhat higher.)

Depending on the quality of the connection, sometimes the data may have to be sent too slowly to be of use, and sometimes error correction may be needed. But digital data can be sent almost unlimited distances almost without errors—as long as it goes slow enough.

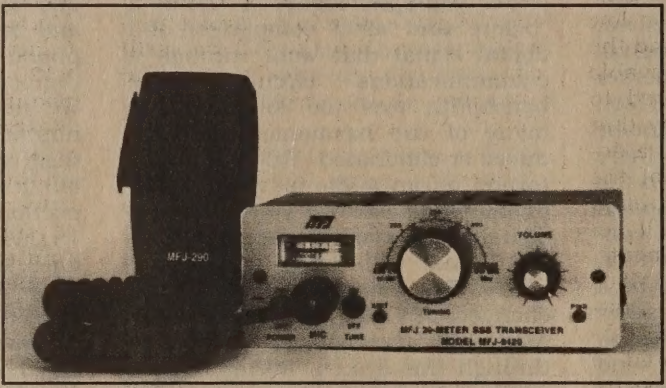
For this reason, sending audio and video analog signals digitally is a useful technique. We will return to this concept later; for now we need just say that the idea is to take the audio or video signal, digitize it with an *analog-to-digital converter*, send the digital information, and then at the receiver convert it back to the audio or video signal with a *digital-to-analog converter*. This method is currently used in compact discs, in digital audio (such as the WAV files in computers), and in digital radio. It is also now used in telephone systems, for sending voice signals through fiber optic cables, and for an entirely new telephone system called ISDN or the Integrated Services Digital Network. ISDN will eventually provide direct digital connections to your home, which can be used not just for phoning your friends, but also for sending digital data and pictures. RF

The MFJ-9420 20 Meter CW Tranceiver

by Morgan W. Godwin W4WFL
205 Boulevard St. Germain, 75007 Paris France

When I began making my first amateur radio forays around Europe some 20 years ago, I must have borne a considerable resemblance to a three-ring traveling circus. With a large tube-type transceiver, often an equally large and even heavier separate power supply, and all of the other bits and pieces I then considered necessary, I must have made a rather striking figure struggling through airport terminals and railway stations. Even then it was becoming rare to find porters to lend a hand with baggage, so by the time I reached my destination I was invariably exhausted and soaked with perspiration.

Today things are quite different. When I decide that I would like to do a bit of operating during my travels, I'm able to tuck everything needed into one of those nice little flight bags one sees everywhere bearing the logos of airlines and tour companies. The nucleus of my present travel set up is an MFJ-9420 20 meter CW transceiver. In fact, that little rig has revolutionized my operating away from home. The other components of my "traveling station" are a 4-amp, 12-VDC supply, an MFJ-16010 random wire ATU, a keyer paddle, a small hand key, a pair of lightweight headphones, a roll of hook-up wire for use as an antenna, several antenna insulators, and a short coax cable with PL-259 connectors for use between the ATU and the rig. Bare bones perhaps, but it works well for me.



The MFJ-92420 20 meter CW transceiver.

Operating

I've always enjoyed and preferred low power operation, so when the MFJ-9420 was announced, I decided that I wanted one. When it arrived, I opened the box and gave it a careful visual check and put it aside as I was unusually busy with other matters. It was several weeks before I got 'round to hooking it up and giving it a try. That evening conditions, while not particularly good, were better than they had been for some time. Connecting it to my multiband vertical through an antenna switch, I was able to rapidly switch back and forth between the little rig and my TS-140S.

Well, everything I was hearing on my TX-140S could be heard on the MFJ-9420 and, to my pleasant surprise, the 9420 handled some types of noise better than the big rig! During a period of approximately an hour, I called six DX stations and received replies from five of them. The average report was 569, not too bad for 5 watts under so-so conditions. Subsequent activity has proven that that first night's activity wasn't a fluke.

Given today's increasingly complex and sophisticated equipment with dozens of knobs and buttons, it's a pleasure to use the MFJ9420 with its main tuning knob, volume control and RIT. While the rig's standard eight-pole crystal filter does a fine job, I personally find the optional MFJ-726 narrow audio filter a worthwhile addition (perhaps I've just become too used to listening with a narrow passband). I also find it convenient to use the optional MFJ-412 plug-in electronic keyer. While I would prefer to always use a hand key, the effects of an old injury have progressively robbed me of dexterity in my right hand. As a result, I find a keyer is an increasing asset.

With the rig adjusted for full break-in, it's a pleasure to operate. If for some years my CW activity dropped in favor of phone operation, it was primarily because of the dreadful so-called semi-break-in that most rigs offered. If I can't have full break-in, I prefer to have the receiver muted during transmit. Why so many manufacturers perpetrated their so-called semi-break-in for so long is one of the great imponderables, but I'm delighted to see that virtually all current HF transceivers feature full break-in.

The vernier tuning spreads the signals out nicely, and while it doesn't provide the feel of tuning a Collins 51J4, it's plenty good enough. There are still lots of signals that drift rather noticeably, so the RIT is handy to have. One of the things that makes the MFJ-9420 a pleasure to operate is its Instant Recovery AGC. It really does an effective job and makes break-in operation a pleasure. With just three controls, I can't think of a simpler or more "user-friendly" rig.

If anyone has doubts about the effectiveness of 5 watts, I hope that my experience over the years will help to lay their concerns to rest. I've found that 5 watts into even a random wire out a window and into a nearby tree, or down the side of a high-rise hotel or apartment block, is capable of producing amazingly good results. All you need to do is to realize that you are using low power,

and to use a minimum of common sense and good judgment. Avoid calling CQ, stay away from pile-ups, look for strong signals to call, and you should have a perfectly respectable percentage of responses and completed contacts. Given reasonable conditions, if you can't work at least a hundred countries with the MFJ-9420 during a couple of contest weekends, then you should look at your operating procedures and make sure that you're getting most of your signal into the antenna.

"...will seem like using a 105 mm howitzer for shooting doves."

The only thing I might change if I were purchasing the rig today would be to get the model for 30 meters as I find it a more interesting and generally more effective band for low power operation. Still, I've found the little rig so interesting and enjoyable to use that I haven't bothered to make mention to the company that the front panel of my unit has a defect with the silk-screening of the markings for the vernier tuning. Perhaps one of these days I'll get round to requesting a replacement.

I would recommend the MFJ-9420 to anyone looking for a first-rate portable or a budget home station rig. Even a newcomer should be able to acquire the skills necessary for effective low power operation within a relatively short period of time. Once those skills are acquired, you'll find that high power operation is not only unnecessary for successful operation, but its use will seem like using a 105 mm howitzer for shooting doves.

The MFJ-9420 is made in the USA and carries the company's one-year "No Matter What" unconditional guarantee.

MFJ has three portable accessories for their CW transceivers: the MFJ-971 portable tuner, which covers 1.8–30 MHz and handles up to 300 watts PEP ($89.95); the MFJ-4114 portable rechargeable power pack ($69.95); and efficient, low-SWR portable folded dipole antennas for each of their transceivers ($34.95). MFJ also offers transceivers in four more bands: the MFJ-9040, which covers the 40 meter band; the MFJ-9030, which covers the 30 meter band; the MFJ-9017, which covers the 17 meter band; and the MFJ-9015, which covers the 15 meter band. These CW transceivers are $179.95 each. RF

continued from page 4

moreLetters

Don Lakenmacher N5UNU On Field Day, my wife AB5RI and I were driving through Wyoming on vacation. We were using a Yaesu 757GX into a 6-foot mag-mounted Outbacker. My wife was driving while I was working a W2 on 20 meters. We were moving along at about 60 mph when suddenly we were hit by a blast of wind which knocked the antenna off the top of the Suburban. She pulled over as soon as she could, but the antenna was dragged quite a ways. I checked the damage: a big dent in the side of the car, a ground-up mag mount, sans magnets, and a well-traveled Outbacker with only half of its stinger and lots of new character marks. But the W2 was still coming through nicely and the antenna still works just fine. Tough rascal.

Steve Loritz KC7COI After reading your editorials for the past three years and coming across two back issues from the mid-seventies at the used bookstore I work at, I am compelled to write you.

I've been interested in cold fusion since reading about it in your editorials and (surprise!) not reading about it anywhere else. Unfortunately, my local library is a bit anemic in the information department so I'll ask you where I can find more information. Some time ago I ran across a copy of your "*Cold Fusion*" magazine at a bookstore, but could not afford the stiff cover price. Be that as it may, my wife and I are very interested in taking advantage of getting in on the ground floor of this tremendous opportunity. Can you help us? Your guidance would be most appreciated.

A couple of other things to pass along to you and anyone else: I have been reading a couple of books that those subscribers to *73* who still read might like to take a look at. The first is Joel Barker's *Future Edge*, published by William Morrow and Co., New York, ISBN 0-688-10936-5. Joel's book will help you be ready for opportunities that will arise in the future and, if you are willing to turn off the TV and get up and do something, give you the tools for success. This book deals with recognizing the paradigms that people and industry have been slaves to when paradigm paralysis sets in and holds them down while those whose anticipation of change, innovative thinking, and drive for excellence causes them to pick up the ball and run. A few examples are in order: digital watches, microcomputers, small energy-efficient cars, total quality management, et al. There is no secret to the success of the leaders in these fields—just an open mind.

Book number two, *The McDougall Plan* by John A. McDougall, MD, published by New Century Publishers, Inc., ISBN 0-8329-0289-6. This book is all about health-supporting diet and lifestyle. If you're tired of paying your doctor a king's ransom for outdated, often food-industry driven false information designed to support him and the pharmaceutical industries, read this eye-opener. It will help you feel better, look better, get your colon regular and allow your body's ability to heal itself save you time, aggravation, and money. John's book exposes the fairy tales that our school system and the food/health industry have been propagating for decades. Wait until you read about how our culture's acceptance of rich foods like meat and dairy as the cornerstone of diet have led to increased disease rates, cancer, fat kids, poor tests scores, lower intelligence...and on, and on, and on. Why do you think people with starch-based, health-supporting diets like those in Asia, the Middle-East, and elsewhere have lower cancer and disease rates, smarter kids, and longer life expectancy?

Enough of that. Wayne, we are having a hard time putting ideas to action. What will it take to get everyone going? Thanks a million.

Steve, I've been trying to get the old duffer hams off their fat butts and into new technologies for 44 years now, so I doubt that your letter will break many away from Gilligan's Island re-runs, or spending hours checking into 75m nets to report no traffic.

Wayne RF

Strange Electronic Problems

Murphy would be proud!

by Dave Miller NZ9E

Just about anyone who's been involved with amateur radio for a number of years has several strange stories to tell related to troubleshooting. It seems that most don't write about them, which is something of a shame, because I love to read about other's experiences. It can often be both humorous and helpful at the same time. So I'm sort of breaking with tradition, you might say, and putting down several of my own for the benefit of anyone who wants to read about them. Please don't be too hard on me if you think that some are too obvious to be considered "strange." They seemed so to me at the time, and, like beauty, strangeness is also in the eye of the beholder!

Years ago, a poor fellow by the name of Murphy somehow was "credited" with all of the oddball things that can happen in electronic circuits; thus, "Murphy's Laws" were born. One of Mr. Murphy's Laws says something to the effect that "if anything can go wrong in an electronic circuit, it will!" There are a number of other "Laws" but I can personally attest to the validity of the first one. Take this story, for instance.

I was working on a 75-watt Novice CW transmitter for a friend some years back. The transmitter was working, but not properly; the plate of the final single tube amplifier would begin to glow red within a short time during key-down tune-up. I found that the bias on the final was too low and that was obviously causing the excessive plate current and the cherry red glow on the final plate itself. It wasn't the easiest of circuits to work on physically, but I began checking all of the parts that might be causing the low-bias condition. They all checked out okay. Fortunately, I was able to read a lower-than-expected resistance from grid to ground on an ohmmeter; so I began disconnecting parts, hoping the reading would substantially change at some point. It didn't. I took out every part in the grid circuit with no real improvement. When I finally got down to just the tube socket itself, I knew that it was probably conducting within its own phenolic insulation, and so I took it out as well. It checked okay! I was now down to just the circuit board, and that was indeed the problem. The circuit board insulating phenolic was conductive between the grid traces and ground, but it couldn't be easily seen visually because of the board's coloring. I was finally able to locate the carbon path within the board itself, break that path with a scribe, and the resistive short disappeared... at last! I then broke the trace just before and just after the carbonized area, and jumpered the break with a short length of wire. After I had put everything back in, the little transmitter worked like a champ. So a printed circuit became a low-value resistor between two of its traces. It doesn't happen often, but it can happen!

Loose Screws

I've run into some really strange problems in circuit boards carrying RF currents. These include things that make absolutely no sense and can eat up hours of troubleshooting time. I've now made it a habit of checking the tightness of all of the little mounting screws used to hold down these boards to the metal chassis beneath. I've cured countless weird occurrences just by doing that at the start. It takes time, but it's been worth it over the years. The equipment manufacturer often relies on the circuit board's mounting screws to provide short RF ground paths to the metal chassis, sometimes even in the middle of the board. Even a slightly high-resistance RF ground anywhere can cause seemingly insoluble problems in any piece of gear. Any solder flux on the ground foil of the circuit board at an attachment point can create a similar situation. Sometimes the condition even varies with heat or humidity as the material expands and contracts. Cleaning the flux off of the board at the screw-down connection points and making sure that the mounting screws are good and snug is the secret formula. Screws holding brackets to the chassis upon which a circuit board is mounted are another source of possible poor ground contact, so they should be checked as well. What looks like ground to the eye may not be to an RF current that's depending upon it.

My Mountainous Experience

Here's a bizarre one that happened to me while I was on an automobile vacation with my family in the Grand Teton Mountains. I had my 2 meter transceiver mounted under the dash and had made any number of really interesting contacts via the repeaters along the way. I was enjoying the hamming experience nearly as much as the grandeur of the scenery that we were passing through, so you can imagine how disappointed I was when the receiver portion of my 2 meter rig conked out all of a sudden as we were nearing Jackson Hole, Wyoming! What a bummer. I hardly noticed the beautiful surrounding snow-capped mountain range as we coasted into town. I had a few small hand tools with me; I always bring a minimal complement and have *always* had to use them. I pulled the 2 meter rig out of the car when we settled into our motel for the evening. The kids wanted to see a bit of the town, so my wife KA9UCK offered to take them on a walking tour so that I could work away on the 2 meter rig for a while. Having a wife who understands something about "ham fever" is a great idea; I highly recommend it.

I brought the transceiver into the motel and removed the covers, giving it a brief visual inspection. Nothing showed up there, so I took it back out to the car and put 12 volts back on it for a powered-up test ses-

sion. To make a long story shorter, I was able to determine that one of the IF transformers in the receiver was intermittent—very intermittent—and I was just about ready to admit that this one would have to wait for a home repair. I was sure it was in the IF can, but I didn't have a soldering iron or solder with me, plus it would be a pretty delicate operation at best. I happened to notice a gas station across from our motel, and a small Radio Shack sign next to it. Since the chap who ran the gas station also had a limited-item Radio Shack franchise, I strolled over to meet him. He had a small soldering iron, desoldering bulb and solder in stock; so I bought them and hurried back to our motel, all the time wondering if I should even try my idea or not. If the break in the coil inside of the IF can was right at the connecting terminal, I had half a chance of fixing it... maybe. I was able to get the tiny IF can out of the transceiver, and even able to get it apart—once it was out—without breaking anything. I found that an end of one of the coils inside hadn't been soldered to its base terminal, therefore causing my intermittent receive problem. I soldered the connection and carefully put everything back together, and it seemed solid as a rock. Success. To check it all out, I gave a couple of calls on simplex and was rewarded by an answer from a fellow ham who had been mountain climbing with a friend high up in the Tetons for the last few days! I could just barely make out the snowy peaks in the distance, where he was making camp for the night, as the sun gradually dropped behind that glorious mountain range. I slept well that night.

Seeing Red!

Have you ever seen a phenolic wafer switch glowing a dull red? That's what I found inside of my friend's 125-watt HF transceiver when he brought it over for me to have a look at one day. He had noticed the power output fluctuating and it never put out more than about half power even at best. I was able to duplicate his complaint all right, but what the actual problem might be had me baffled, until I saw the light—the dull red glow mentioned above. After trying a number of "standard" corrective procedures, all to no avail, I turned off the room lights and began looking around. Something smelled hot, but I couldn't see just exactly what it was until I noticed the rear section of the bandswitch *glowing red.* I've never run into that one before, but as Murphy said, "There's always a first time!" In any event, this transceiver used a pair of 6146s and a Pi-network final, so very high RF voltages were developed. The rear section of the bandswitch was in the final amplifier compartment and was used to switch in various capacitors for resonating the Pi-net on the different bands. The material used to construct the switch was phenolic—we've already seen that phenolic can become semiconductive—and apparently began breaking-down over time until it would no longer support the high RF voltages. It became a high-power "dummy load" of sorts, and glowed red from the amount of power that it was trying to dissipate. The supporting screws and standoffs that made up the switch's mechanical structure only added to the dilemma; they were at ground potential and too close to the contacts with high voltage for comfort. A bad soldering job on the contact

closest to the supporting screws added more stress, and the whole house of cards finally gave way. The replacement switch that I put in for him had slightly better design, but I would have felt much more secure if the manufacturer had instead used ceramic insulating material throughout, especially at these high RF voltage levels. We'll see how long the new one lasts. There's only so much you can do when the original equipment manufacturer's parts are marginally constructed and there's no available substitute possessing a better design.

The Slip-Fit Capacitor

By the way, that same transceiver also had an intermittent VFO condition. It worked most of the time, but not always. Tapping on it would fix the problem—sometimes for long periods—but I felt that there had to be something more that I could do for it. After removing the VFO and lifting off its cover, I discovered a ceramic disc capacitor that had never been soldered to its circuit board pad. This was a 25-plus-year-old radio, and I'm still not sure how it managed to work (most of the time) for that long with the capacitor's wire lead just bent over the edge of the circuit board's foil solder pad. How the factory managed to miss just one connection is another matter, but it does go to show what can happen in the real world, and why it often pays to make a visual inspection of any circuit board before beginning serious troubleshooting.

Unexpected Conductive Paths

We've all seen those tiny round solder-balls stuck to the flux coating on the underside of various electronic circuit boards, and though I've never found one that I was certain was causing a problem, they make me unsettled nonetheless. I'm convinced that there must be occasions when they've created intermittent shorts. One thing I have run into is semiconductive adhesives—the adhesives sometimes used to hold parts down to the underside of circuit boards—that become partially conductive and create strange, variable problems. It seems that some of these adhesives—primarily those that become very hard and brittle—can also become hygroscopic, picking up moisture and turning conductive because of that. I've a hunch that some may also change chemically and therefore produce more stable high-impedance leakage paths. In certain circuits these Hi-Z leakage paths can upset the circuit's normal mode of operation and create strange, unpredictable symptoms. Removing the offending adhesive cures the problem, but it requires being aware of the possibility even to think of that as the source of the problem.

When a Capacitor Is a Resistor

Here's one, though not in a piece of amateur gear, that I thought was interesting. I once found a capacitor—the ceramic disc variety—in my microwave oven's control circuitry that thought it was a resistor. The oven's control circuit was completely dead, I couldn't get a schematic for it, and I was told I'd simply have to purchase a whole new board for about $150 because they didn't troubleshoot on a component-level very much any more... it's too costly. That was half of the original price of the oven and naturally it was just out of warranty. I decided to start checking parts at random

before replacing the entire board—what was there to lose? I began by lifting one end of each diode and checking it; all were okay. The electrolytic capacitors proved the same: nothing out of the ordinary. I was halfway (or better) through in checking the ceramic disc capacitors when I found one that read about 10 ohms on my ohmmeter. It was nice and stable, too, but not what the circuit wanted to see. So for the cost of a new disc cap, I saved the price of a whole new board, and it's been working fine for years since then.

Other Parts Problems

I once encountered a resistor that was so temperature sensitive that it might well have been used as the sensing element in an electronic thermometer circuit; ICs that worked fine when hot, but not when cold, or vice versa; transistors that behaved in a similar fashion; and diodes that were mismarked at the factory and therefore installed incorrectly. I've also experienced hairline foil-shorts in circuit boards that could not be seen with the naked eye and IC sockets whose pins did not make contact from the bottom of the socket to the top, either broken inside or coated with some foreign material that made good contact impossible. It's usually risky to take anything for granted, yet we all do and we become Murphy's victim from time to time. I hope that my "true confessions" have been entertaining as well as informative. It would be interesting for me to see some from others who've had more or different experiences. Mine are probably just the tip of old Mr. Murphy's iceberg! RF

No Cleveland Scanning

If you live in the city of Cleveland Ohio and own a scanner radio, you soon will have very little to listen to. This is because Cleveland is the first American city to fully implement a fully encrypted trunked radio system that is specifically designed to keep the ears of the general public out. According to a story by Stephen Bellamy AA8MX, appearing in *Popular Communications* magazine, Cleveland's twenty municipal divisions, including police, fire, and emergency medical services, will soon be on the 800-MHz digital trunked system. Once fully operational, the only way to eavesdrop will be with a special receiver manufactured by Motorola, a receiver that is not for sale to the general public and whose operational technology is a closely guarded secret. And even if someone were to get their hands on one of these next generation two-way radios, it will do them little good. In addition to the receiver, he would also need the proprietary decoding algorithm that Cleveland is making available only to those they authorize to listen in. Scanner enthusiasts, ham radio operators, and the general public will not be included in this group. Nor will they be able to buy new radios to receive the digitally encoded messages and Motorola appears unwilling to license its technology to anyone providing hobbyist monitor radios to the general public. So, once the new Cleveland radio system is fully operational, all a scanner listener will hear is some hashy-sounding noise if they tune in. More information on what's happening in Cleveland can be found on page 14 of the October issue of *Popular Communications* magazine. *TNX Newsline.*

Ham Column Canceled

Speaking about *Popular Communications* magazine, word that a weekly column on ham radio, communications, and broadcasting written by *Pop Comm* editor, Chuck Gysi N2DUP, has been canceled due to budgetary constraints at an Iowa newspaper.

The column, which promoted amateur radio activities in eastern Iowa and western Illinois for more than five years, appeared for the last time on September 3rd in *The Hawk Eye*, a daily morning newspaper in Burlington, Iowa, with a circulation of about 20,000. Gysi wrote 284 "On The Air" columns during its run. It is uncertain at present whether it will be picked up by any other publication. Gysi's ham column was one of only a handful that appear in newspapers across the United States. *TNX Newsline.*

Repeater Meeting

October 7th may be an important day for amateur radio. That's when an ARRL-sponsored repeater coordinator's conference takes place in St. Louis, Missouri. The meeting will be a chance for repeater frequency coordinators from across the nation to discuss issues and problems of mutual concern. Some of the issues likely to come up promise to be subjects of disagreement. Depending on where you live in the US, certain parts of amateur frequency bands may be designated for particular modes of operation, such as link frequencies or amateur television. The same frequencies are often used for different types of communications in different areas ...even though the ARRL suggests a nationwide bandplan. "There's just no way to do a national band plan on most of the bands because of what's going on locally," says Dave Baughn KX4I, frequency coordinator for the Alabama Repeater Council, who expects bandplanning to be discussed during the meeting. "There's a possibility that the ARRL will try to push a national bandplanning on us. I think that will be resisted very vigorously." The possibility of licensing repeaters, something that was done previously, may also come up. Baughn strongly opposes the idea. Developing a single point of contact between coordinating groups and the FCC is expected to be a main topic. Baughn says he hopes coordinating groups nationwide will be able to develop a better relationship with the FCC. "I hope that I get to meet some of the other coordinators and get to hear some of the problems they are having and talk them over a little bit to help us out here" KX4I says. Though there could be heated discussion on some subjects, Baughn calls the St. Louis gathering a good idea. Baughn will be one of about seventy representatives of repeater councils from around the country attending the meeting. What these people decide will have a direct impact on your day-to-day repeater operation for decades to come.

Newsline is teaming up with *World Radio* magazine to bring in-depth coverage of this meeting to the amateur public. *TNX Newsline.*

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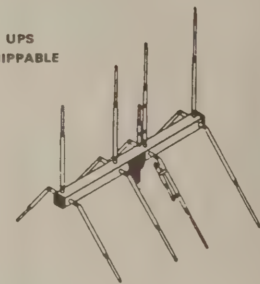

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The Post Graduate Novice

What Your Instructor Didn't Tell You About Hardware

by David McLanahan WA1FHB and Margaret A. LePage N1FBC

All of us enjoy hamfests! They are a great way to pick up badly needed parts (now that no other reasonable sources are available, short of mail order), and there's always that piece of exotic military or commercial surplus equipment that we can steal for cents on the dollar.

Of course, the first question is generally, "Does it work?" and if the seller starts looking shifty-eyed, we usually walk away. For many of us, however, this question may not be as important as it first seems.

As we all know, the ham license requirements are bare-bones, and you can easily pass all the amateur written tests without knowing what a tube, resistor, or transistor really looks like. How about buying some of those cheap, possibly defective parts for the express purpose of autopsies?

For example, all of us know about crystals, don't we? (It may come as a surprise, but the new synthesized rigs rely on crystals, too.) A crystal is not a little flat silver-colored can with two wires or pins coming out; it's a small slip of quartz in a clever spring clip mounting. Keep an eye out for the big, old bakelite FT-243 crystals (that need only a screwdriver to open) and find out for yourself.

Vacuum tubes and panel meters are also prime candidates for study. Of course, with a glass bottle, many vacuum tubes are partly inspectable as is, but with the glass off, you can see more of the intricate structure and it can be disassembled. Before you take the glass off, record the tube number and look it up or ask a friend what type of tube it is (was?).

Determining that number may be a bit tricky. If you can't find it, either on the base or the side of the tube or around the top, after gentle cleaning try breathing on the tube and see if it shows up in the mist that forms. (Vigorous cleaning may remove the last traces of the number!)

See how many of the parts (heater, cathode, grids, plate) you can identify. By comparing pin numbers between the tube and its base diagram in the literature, you can generally identify the various components. Obviously, removing the glass without damaging the elements inside is a tricky operation. I suggest wrapping the bottle loosely in a cloth (to contain flying fragments) and crushing it gently in a vise.

Have you ever wondered what's inside a toggle switch or circuit breaker? (If you open a couple of cheap circuit breakers, you may begin to understand why a substantial minority of technical people refuse to give up their fuses!)

Any of the metal-can transistors (e.g., TO-3 or TO-5) are grist for our mill, but the plastic-encapsulated ones (like TO-92) probably aren't worth the hassle required to try to open them (see what's inside them by inspecting a 2N5777 or similar optical device that uses clear plastic).

> "there's always the assembly that contains a well-hidden spring that sprays tiny parts"

Departing a bit from ham radio, there are many sophisticated computer devices that can be cheaply obtained for autopsy. Prime examples are dot matrix print heads, magnetic core memories, hard-disk drives, and of course the ubiquitous ICs.

You can get a general idea of the innards of an IC by inspecting a quartz-covered EPROM, but for a more varied and interesting circuit pattern, try a CPU, such as a Z-80 or an 8086. The IC package consists of a base, with the pins and a cavity for the actual chip, and a cover. Manufacturers do their best to make the seal between base and cover solid and permanent, but with a sharp cold chisel hammered in edgewise just even with the tops of the pins, you can often make that joint say, "Uncle!"

The resulting "chip" is best inspected with a 20x or higher-power magnifier or microscope. We've noticed the increased complexity and density (parts or foil runs per square inch) of printed circuit cards over the past 15 or 20 years. Opening various vintages of IC will show the same thing happening on the chips (of course, this also shows up in the data sheets as more and more functions are crammed into a 16- or 24-pin DIP header)!

Computer key-switches make interesting victims, either loose as replacement parts or still on the keyboard assembly. There are several different mechanisms in use for key-switches—direct contact (spring type with a wiping motion), reed relay (contacts sealed in a glass tube and actuated by a little magnet), magnetic saturation (a small toroid coil and a magnet), and even Hall Effect (with an IC in every switch!). And then there's the flat-pack "membrane" keyboard where a touch causes a flexible, conductive, rubber-like sheet to short pads on the back plate.

Of course, contrary to current fashion in components, big is beautiful! If you can avoid it, you don't want to be doing your autopsies under a (surplus, of course) microscope, although a powerful magnifier is always useful.

Also, if you can, try to get several identical or similar items. It is often tricky to figure out how to get into an assembly, and you may destroy the first one learning how to open it. And there's always the "Oh m'gosh!" assembly that contains a well-hidden spring that sprays tiny parts about the room when a perfectly innocent looking screw is loosened.

On the other hand, don't pass up that anonymous, grungy black can assembly with the 30-pin connector on it—things like that have been

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Antennas, etc.

by Joseph J. Carr K4IPV

To Balun or Not

You don't go too far into the subject of ham radio antennas before you find something called a "balun" transformer. These transformers are used to match impedances, and to convert back and forth between balanced and unbalanced loads. They are a constant mainstay of amateur radio antenna construction.

So, what's a "balanced" or "unbalanced" load? An unbalanced load is an antenna, dummy load, or anything else that receives RF power, and has *one end grounded, and the other end ungrounded.* A balanced load has neither end grounded. Antenna examples are the quarter-wavelength vertical (unbalanced load) and half-wavelength horizontal dipole (balanced load). The term "balun" is an acronym for *bal*anced-*un*balanced, which reflects the nature of the transformation done.

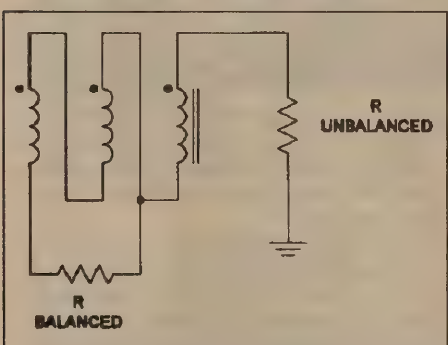


Fig. 1A. 1:1 balun

Figure 1 shows the circuits for several different types of balun transformer. In Figure 1A, the balun has a 1:1 impedance ratio, which means the impedance of the balanced side is the same as the impedance on the unbalanced side. If you connect a 50-ohm balanced load across the balanced output, the impedance reflected to the unbalanced primary is also 50 ohms. This type of transformer can be used between the feedpoint of a standard dipole, and its 75-ohm transmission line.

The balun version in Figure 1B has a 4:1 impedance ratio; i.e., a 300-ohm balanced load looks like a 75-ohm unbalanced impedance looking into the primary winding. This type of balun transformer is used at the feedpoint of a folded dipole, which has an impedance near 300 ohms.

In Figure 1C, the transformer has a 16:1 ratio. Note that both ends are unbalanced; this type of transformer is usually called an UN-UN (although some people, improperly but not without reason, call all such transformers baluns). This type of transformer can be used to match the resistance of some vertical antennas to 52-ohm coaxial cable (vertical antenna feedpoint impedance can vary from about 2 or 3 ohms up to 37 ohms, depending on several factors).

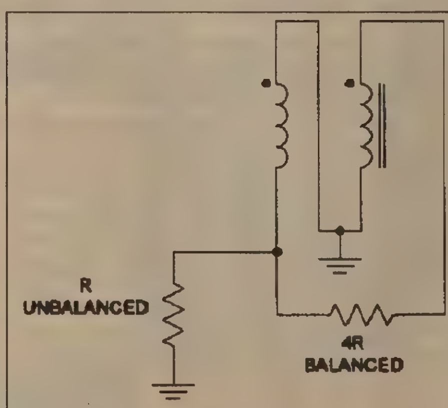


Fig. 1B. 4:1 balun

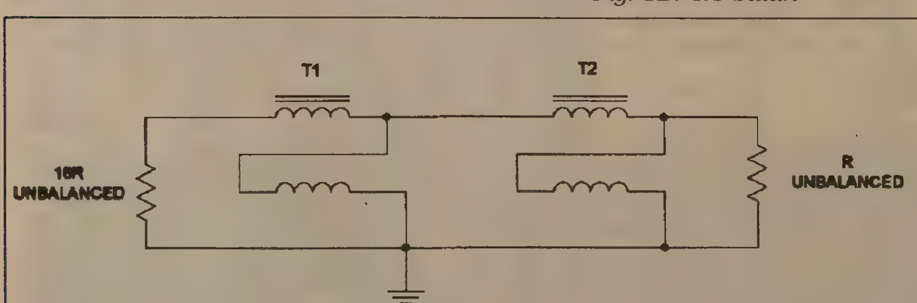


Fig. 1C. 16:1 UN-UN.

Winding Baluns

Baluns, UN-UNs and BAL-BALs can be wound on any coil form. The first balun that I saw was a Heathkit model made in the 1950s. That balun used air-core coils. The coils were kind of special, however, in that they each had two coils bifilar wound (i.e., the two coils were wound on the same form, with turns from each alternating with the other, side-by-side).

The biggest majority of homebrew ham baluns are wound on toroid ("doughnut"-shaped) forms, as shown in Figure 2. In Figure 2A, you will see the toroid form showing the critical dimensions (o.d., i.d. and h). These cores come in sizes from 0.25 to 6 inches. For transmitter applications (except QRP), the larger sizes are typically used. Figure 2B shows an actual balun transformer from my junk box. This one was wound with three windings, which were laid down in the trifilar manner. Note that each turn has three separate wires side-by-side, indicating the trifilarness of the winding.

A balun winding method is to use the binocular balun core shown in Figure 3. These cores contain two holes, and the wires are wound through them. These cores are only available in small sizes, so are limited to making coils and transformers for receiving or test equipment applications. Transmitting baluns for anything higher than QRP can be made from toroids by stacking three or four to make each "hole,"

and then using two such stacks bound together with tape or a proper cement. One advantage of the commercial (Amidon Associates, for example) binocular balun cores is that they come with very high permeability ratings. The AL value of some of these cores are numbers like 2850 and 8000, so high-value coils and chokes can be made using relatively few turns.

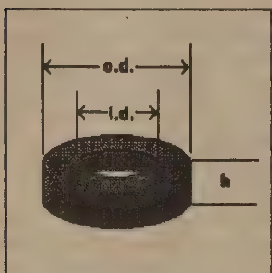


Figure 2A Toroid core.

Figure 2B balun wound on a large toroid core.

A final core for making baluns is the ferrite or powdered iron rod (Figure 4). This method is used occasionally to make filament RF chokes for high-power RF linear amplifiers, as well as moderate power level balun transformers. This transformer is designed for moderate power levels (50 watts or so), and uses two bifilar windings of #22 hook-up wire.

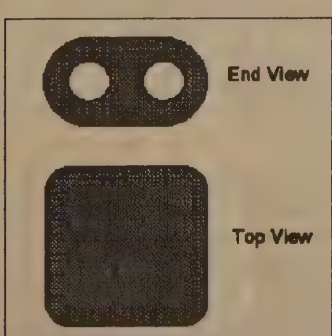


Figure 3. Binocular balun core.

Mounting Toroid Balun Transformers

Unless the balun is encapsulated in plastic and hung from the antenna feedpoint, it will be necessary to mount the transformer to a surface. Two situations are seen. First, as a standalone transformer in its own shielded housing; second, as a balanced output to a normally unbalanced antenna tuning unit. For example, most transmatches have a second output option that feeds balanced lines. The transformation is usually provided by a 4:1 balun transformer.

Figure 4. Ferrite rod balun.

In Figure 5A, you see a toroidal transformer (balun or otherwise) mounted to a surface. The wires might or might not pass through the surface (as it would on a printed circuit board). The bolt and hex nut must not be made of metal or they will interfere with the operation of the transformer or coil. Use nylon or other insulating hardware instead of metal. The washer on top can be fiber, plastic, nylon or anything non-conducting. If the surface the coil or transformer is mounted on is metallic, use an insulating washer underneath the toroid as well.

Figure 5B shows a modification on the theme in which two toroids are stacked on top of one another in order to increase the power level of the assembly (only one bifilar or trifilar winding is used, however; it covers both cores). Washers are used above and below the toroid stack because this configuration is almost always used in the antenna-tuning unit situation, so it will likely be mounted on a metal surface of the cabinet. In the case of higher-power units, make those washers 3/16 to 3/8 inch thick. The cores are wrapped with a fiberglas tape both before winding and afterwards. Again, nylon or plastic hardware is used for the fasteners.

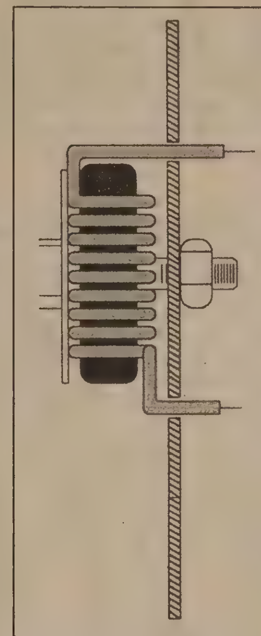


Figure 5A. Toroidal transformer.

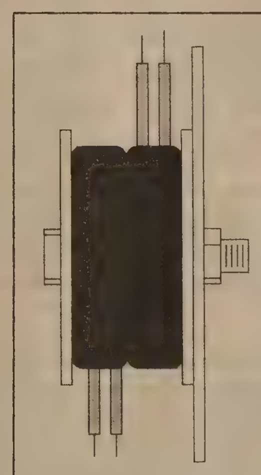


Figure 5B. Two toroids stacked on top of one another.

Connections...

The main purpose of this column is to provide a service to the readers, especially newcomers to the ham radio hobby. I can do a better job of that task if I know what you would like to read about. If you have comments, questions, suggestions, topics that you would like to see, criticisms or brickbats, then get in touch with me. I can be reached via snailmail at P.O. Box 1099, Falls Church, VA, 22041, or via E-mail at @internet:CARRJJ@AOL.COM RF

Post Grad...*continued from page 19*
known to contain jewel-like precision gyroscopes from missile navigation systems or air craft autopilots.

Having rooted around in some of these assemblies with the joyous freedom of not having to worry about voiding the warranty and with no fear of "busting" it (it was busted when you started), you just might suddenly find yourself able to really fix them.

What to Do with the Remains

The main point of these exercises is the knowledge and experience that you gain by doing them. However, there are other possible benefits. While visiting an artist acquaintance, I was surprised to find several electronic assemblies and circuit boards hanging as "art objects" on the wall. They had come from a (nonelectronic) flea market. My friend was enthralled with a brief explanation of what each part was.

A second possible use is as an instructional "visual aid" to see how the assembly worked. Perhaps the most dramatic (and time-consuming) preparation for this use would be a methacrylate embedment. Methacrylate is a clear liquid that when "polymerized" by the addition of a catalyst, turns to a clear solid. Often seen in arts and craft stores with collections of seeds, grains, or other natural objects, an embedment can provide a "real life" version of the draftsman's "Illustrated Parts Breakdown" or exploded view.

> "grab screwdriver, file, desoldering tool, and hacksaw... Who knows? You'll probably strike gold—real gold!"

Complete details of how to make an embedment are beyond the scope of this article, but, briefly, you pour a small amount of the catalyzed methacrylate into a form and, just as it starts to gel, you position the first part of the assembly. Additional parts and methacrylate layers are added in sequence until it's finished (the last layer may contain a dye to provide a base and possibly a neat little note to identify the assembly).

This is not all as easy as I've made it sound. For example, the methacrylate is "exothermic" as it polymerizes. It gives off heat, and if the heat is not controlled, it can damage the specimen or cause the block to crack, but the process is certainly do-able on the kitchen table, with a few hours and lots of patience.

Caveats

There are a few things to watch out for when doing autopsies on old surplus. Some of the higher-power tubes use a ceramic that, when broken, releases a toxic dust. Mercury-wetted relays and contactors obviously contain mercury, an elusive metal that, if even a bit of it gets loose, will lie around in cracks on the floor evaporating and generating a toxic vapor.

Similarly, some types of fluorescent lights and cathode-ray tubes contain a toxic phosphor coating on the inside of the glass envelope that's particularly nasty if it gets into a cut. Speaking of CRTs, they contain a substantial volume of high vacuum—close kin to a bomb if broken. Most of the types used in modern television sets and computer video monitors have an integral safety-glass shield covering the face, but that offers little protection from flying glass from the rear of the tube if the tube's been removed from its cabinet or housing.

Of course, if you tear into any type of high-voltage capacitor, make sure that it's entirely discharged. Some types can be short-circuited momentarily and then build up a charge after the short is removed. Short its terminals again with an insulated tool, and if you get a spark, set it aside for another day...

Don't let these warnings put you off. Use common sense! If you run into any liquid, treat it as toxic and a skin irritant; beware of any peculiar-looking materials you might find, and if there is any chance of something flying, wear eye or face protection. During WWII, there were a few highly classified electronic assemblies that contained "self-destruct" explosive changes. These charges were carefully scaled so that the explosive force was confined by the case. Of course, if the unit is out of the case... These units were rare, generally carefully marked, and never left the hands of the government with their charges intact, but a couple were found in surplus years ago.

Now, grab screwdriver, file, desoldering tool, and hacksaw, and start your "post-novice" education! Who knows? You'll probably strike gold—real gold! RF

What's Next?

by Carole Perry WB2MGP

What's In A Name?

There are many wonderful "spin-off" lessons into other areas of school curricula when you teach ham radio in the classroom. One of the most fertile areas of study after a radio contact is geography. The children in a ham radio class come to realize that geography is a lot more than just locating a place on a map. It deals with the history, culture, climate and people of a particular region. The day to day living and current happenings in different parts of the world are all brought live into your classroom via the radio each day.

I try to encourage my students to be creative with the reports and projects they hand in. It's *boring* to sift through page after page of computer generated or encyclopedia copied material. This term, several of my radio students really went all out to make interesting presentations. Here's one you may want to copy and use in your own classroom to start a geography lesson off in a fun way.

The students made a chart with some license plate mottoes they spotted from other states. Some of the histories behind the mottoes were either pretty silly or quite funny. So several children compiled a lit of all 50 states and their respective nicknames.

Alabama—comes from a Choctaw Indian word meaning "thicket clearer" or "vegetation gatherers." Alabama is officially nicknamed the "Yellowhammer" in honor of the state bird, a yellowhammer, better known as a woodpecker.

Alaska—is a combination of a native Aleut word meaning either "great land" or "that which the sea breaks against." Now nicknamed the Last Frontier and Land of the Midnight Sun. It used to be nicknamed "Seward's Icebox" or "Seward's Folly."

Arizona—comes from the Papago Indian word, arizonac, meaning "little spring." Its official nickname is the Grand Canyon State.

Arkansas—comes from a Sioux word of unknown meaning; akenzea. It's official nickname is the Land of Opportunity.

California—the origin of the Golden State's name is a bit obscure. One theory suggests it comes from the Spanish words caliente fornalla, or "hot furnace."

Colorado—derived from the Spanish word for "red" or "ruddy." It's officially nicknamed the Centennial State.

Connecticut—is derived from an Indian name meaning "beside the long tidal river." Its official designation is the Constitution State. Its official nickname is the Nutmeg State.

Delaware—first of the 13 original states to ratify the Constitution is the First State. But the state's best nickname may be the Blue Hen State, in honor of the ferocious breed of fighting chicken popular during the revolutionary era.

Florida—named from the Spanish for "feast of flowers." Nicknamed the Sunshine State, it's often been called the Winter Salad Bowl State.

Georgia—Named after King George II of England, its nickname is the Peach State, even though other states grow more peaches.

Hawaii—Known as the Aloha State, Hawaii is also called the Pineapple State for its most important agricultural product.

Idaho—has the singular distinction of having a name that doesn't mean anything. Known as the Gem State for its many precious stones, it is also the Spud State because it produces and processes about one fourth of America's potato crop.

Illinois—comes from the Indian name Inini, meaning "tribe of superior men." The Prairie State is also known as the Land of Lincoln in honor of the 16th president.

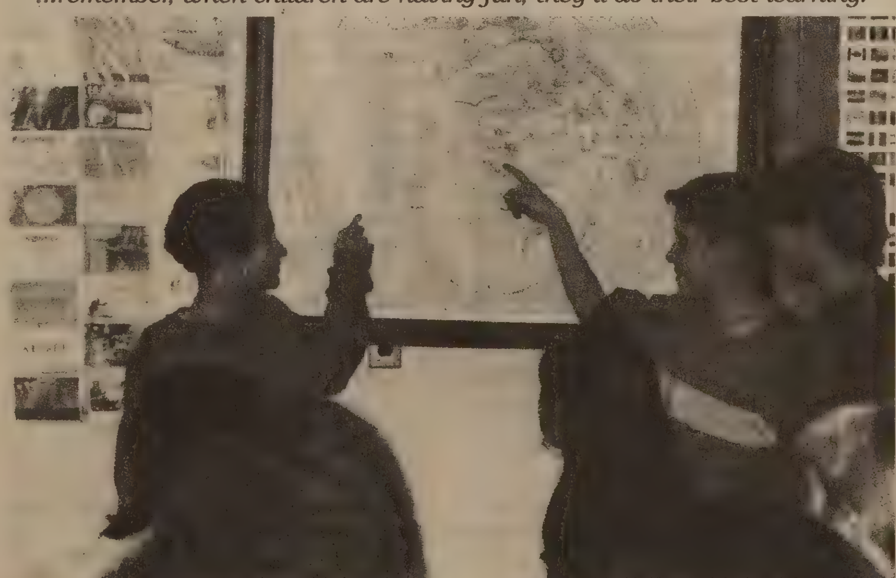
Indiana—means "land of Indians." Known as the Hoosier State whose origin is unclear.

Iowa—from an obscure Indian name which probably means "the beautiful land." An old French map spells the name Ouaouiatonon. It is also called the Hawkeye State in honor of the Indian Chief Hawkeye.

Kansas—comes from the Siouan word kansa, meaning "people of the south wind." An interesting nickname is the Salt of the Earth, as the

continued on page 25

"...remember, when children are having fun, they'll do their best learning."



The Tech Side

by Michael Jay Geier KB1UM

Adaptability

If you're like most of us electronics nuts, you like little gadgets. What with your ham HT (handheld transceiver, or "walkie") and, perhaps, a portable CD player or pocket TV, your house probably contains more than the average number of battery-operated toys. If you bought them new, they most likely came with their own AC adapters. But, if you got some of them at hamfests, you may wish to rig up your own adapters to replace ones long lost by the sellers. So, what's the big deal? You just go out and get one of the same voltage and with the same plug and plug it in, right?

ZAP!

Not so fast. If you do that, you run a pretty good chance of destroying your new toy! Fact is, AC adapters may look simple, but mating one to an unrelated device takes some knowledge, and often a measurement or two. Get it wrong and it's good-bye to your device. So, let's take a look at how to work with AC adapters.

The Three Elements

You have three things to worry about: voltage, current and polarity (which part of the plug is positive and which is negative). The last one is, perhaps, the most crucial. While many devices can stand a few moments of overly high voltage, connecting the polarity backwards will just about always cause serious damage. In fact, as a former service technician, I'd say that a significant percentage of items brought in for service has been damaged in precisely that way. Always keep this in mind: just because an AC adapter has the same plug doesn't mean the polarity is the same as your device's! Believe it or not, sometimes that's true even for adapters made by the same company. So, be sure to measure the voltage coming from the adapter, at the plug, to confirm the proper polarity.

But how do you know the polarity you need? Usually, it'll be marked on the device's case, next to the power input jack, in pictorial form. Not always, though. Some gadgets have no markings at all, leaving you to wonder what is required. *Never* plug into an unknown jack, hoping you'll get it right; you have a 50 percent chance of destroying your device! In this case, there's a couple of things you can try. First, get a plug that fits the jack, with no adapter connected to it. Now, connect it to your voltmeter, putting the red (+) wire onto the center pin of the plug. Put batteries in your device and turn it on. Now, insert the plug, but not all the way. Push it in until you just start to feel resistance. That way, you won't disconnect the batteries from the circuit, as you would if you pressed the plug in all the way. If you're lucky, you'll see the battery voltage on your meter. If there's no minus sign on your digital meter, or the needle moves the correct way on your analog meter, then you know the jack is center positive, which means the tip or center pin is connected to positive. If the digital meter shows a minus sign, or the analog meter moves backwards, then you know the center pin is negative.

If you can't get a reading that way, you'll have to open up your gadget. Correctly interpreting the internal connections takes some experience, but I'll try to guide you through it. Remove the batteries, open up the case and look at the power input jack. Most likely, one of its connections to the circuit board will go to a very large, wide trace that seems to go all over the place. Usually, that's circuit ground and is nearly always negative, except perhaps in some very old gear. To be sure, look around near the jack for some electrolytic capacitors, which look like tallish cans resembling miniature soda cans, and are marked with things like "100 µF, 25 VDC." Usually, those parts will have one lead connected to that big trace. Fortunately, they also have polarity markings. At one time, the positive lead was marked with a + sign; these days, it's usually the negative one marked with a - sign. See which one goes to that trace, and you've deduced the input polarity. If the negative goes to the ground trace (which it probably will), you know the pin on the jack going to the same trace is also negative. To confirm, plug an unconnected plug into the power jack and use your ohmmeter to check which lead is connected to the ground trace. By the way, when you use this method, be absolutely certain you're not confusing the ground trace with the power buss! Sometimes that trace will be fairly large, too, but it's usually smaller, and it won't be connected to metal shields and other such structures; you can count on their being at circuit ground, except perhaps for the occasional heatsink on a big power transistor. If you can find any shields covering portions of the boards, just connect one end of your ohmmeter to the shield and the other to your unconnected plug. Try both parts of the plug, and you'll quickly find which end is ground. To be sure it's negative, look for those electrolytic capacitors.

Once you know the required polarity, wire up your AC adapter's plug to match it. That is, positive to positive and negative to negative.

AC/DC

All of this assumes, of course, that there is a polarity in the first place! With the vast majority of devices, there is; they run on DC power. Now and then, though, you may run into something which takes AC power in and converts it into DC inside! With such a unit, there is no polarity associated with the power input connector; it doesn't matter which way you connect the adapter. Why do they do that? Some circuits need both polarities, and that method lets them

derive them from a single adapter. Please note that, when I say AC power is going in, I don't mean at 120 volts! These things still need low voltage from a wall cube; they just split the power supply function into two parts: voltage conversion in the cube and the AC-to-DC conversion and filtering in the device. The giveaway is that the power jack goes to a bunch of diodes before the electrolytics, and some of the capacitors have positive to ground, along with some having negative to ground. You won't see many items like this, but now and then you may run into one. In particular, phone answering machines tend to be wired like that, along with some gadgets meant to be connected to the serial ports of computers.

Voltage and Current

Hopefully, you've gotten the crucial polarity issue squared away. Next, you need to worry about getting the right voltage to your device. You just match the required voltage to the one printed on the AC adapter, right? Unfortunately, it's not that simple. Next time, we'll continue with this topic. Until then, 73 from KB1UM. RF

Militia Nets

With all the talk about militia groups in the news these days, it may not be much of a surprise that several of these groups are taking to the ham bands. According to several packet radio postings, a national high frequency militia radio network is being formed. Those behind the net say that they are doing it in the hope that, once initial contact between the various elements of the militias is accomplished, they will each develop their own net times and frequencies. The first of these regional militia nets was scheduled to begin earlier this month on Friday at 22:00 Eastern Time on 3960 KHz. This is followed by a national Militia Net inter-tie at 22:45 Eastern Time on 14.275 MHz. If these frequencies are busy (and if the net tries to use 14.275 you probably will hear some gunfire), you might want to look up the band. The nets are reportedly controlled from (and we quote from their press release) "Dallas, in the Free Republic of Texas." *TNX Newsline.*

What's Next...*continued from page 23*

state has enough salt reserves to last for several hundred thousand years.

Kentucky—is derived from an Iroquoian word meaning "land of tomorrow." It is best known as the Bluegrass State for the native grass characteristic of its famed racehorse breeding region.

Louisiana—named for King Louis XIV, it's known as the Pelican State and the Sugar State.

Maine—first used to distinguish the "mainland" from the offshore islands. With nearly 89% of its territory forested, its easy to understand its nickname, the Pine Tree State.

Maryland—named in honor of Henrietta Maria, wife of Charles II. Often called the Free State or the Old Line State.

Massachusetts—comes from two Indian words meaning "great mountain place." Its nicknames include, the Bay State, the Old Colony State, and the Bean-eating State.

Michigan—from two Indian words meaning "great lake." It's also called the Wolverine State for the bushy-tailed animal that is not a wolf.

Minnesota—from the Dakota Indians meaning "sky-tinted water." Its most famous nicknames are the Land of 10,000 Lakes, the Gopher State, and the Bread and Butter State.

Mississippi—from an Indian word meaning "father of the waters." It's officially called the Magnolia State.

Missouri—named for the Missouri tribe from a word meaning "town of the large canoes." It's known as the Show-me State. For some reason, Missouri is also known as the Puke State.

Montana—from the Spanish for "mountainous." Officially nicknamed the Treasure State; most people call it the Big Sky State.

Nebraska—from an Oto Indian word meaning "flat water." Best known as the Cornhusker State—it is more colorfully nicknamed the Bug-Eating State, in honor of bull bats, which eat bugs.

Nevada—from the Spanish meaning "snowcapped." Its nickname is the Silver State.

New Hampshire—named for the English county of Hampshire. Nicknamed the Granite State, it's best known for its defiant motto Live Free or Die.

New Jersey—named for the Isle of Jersey in the English Channel. Its nickname is the Garden State.

New Mexico—derived from the country of Mexico. the official bird is the Road Runner. It also has an official state cookie, the bizcochito, and has been called the Vermin State.

New York—originally called New Amsterdam, it was renamed in honor of the English Duke of York. Its official nickname is the Empire State.

In the interest of space, I'll conclude with my home state of New York. For the rest of the list; either drop me a line or get a copy of *Don't Know Much About Geography* by Kenneth Davis. The kids like to use that book as a reference.

Always remember, when children are having fun, they'll do their best learning. RF

No Cel-phones on Airplanes

Not only can the captain of a commercial airliner ban you from using a cellular telephone while in-flight, so can the FCC. In fact, the commission did so back in December of 1991 when it issued a Report and Order on CC Docket 88-411, where it totally banned the use of all cellular telephones on any aircraft while in flight. The agency did not take this action primarily as a safety precaution because it feared interference to an aircraft navigation and communication systems. That came a few years later when the airline industry itself conducted an in-depth study of the potential problems caused by cel-phones and other electronic devices. Rather, the prohibition was put in place to protect the cellular service itself from interference to multiple cell sites because of the wide coverage possible from altitude.

Any ham who has ever operated a two meter hand held from a private plane knows that its possible to talk on several repeaters simultaneously from only a few thousand feet up. Can you imagine the havoc that even a low power pocket phone would have from, say, 30,000 feet? Well, the FCC can, and as a result the language in the Report and Order in docket 88-411 is very unambiguous. It simply says "No." You cannot operate a cellular telephone from any aircraft—large or small, commercial or non-commercial—while that aircraft is in flight.

The FCC did not ban the use of cellular telephones while a plane is on the ground, and many private pilots carry pocket phones for use after landing. But most airlines, and then also the Federal Aviation Administration, took up where the FCC rules left off. They have instituted an across-the-board ban on the use of any transmitting device including cellular telephones and ham radio transceivers on board any commercial airliner at all times, even when the doors are open and the aircraft is standing at the gate. *TNX Newsline.*

Radio Magic

by Michael Bryce WB8VGE

Getting at the Glitch

Got your new kit all put together. Feeling rather proud of yourself 'cause you don't have a single left over part. Taking a deep breath, you apply power, cross your fingers, and flip the switch. No smoke. Good. Now let's turn up the volume control and take a listen. Nothing! Whoa! Loose connection maybe? Nope. Still nada. Humm, getting kinda mad by now, I bet.

Well, I'm not going to harp on the fact that the reason 90 percent of all kits that don't work from the get go don't because of bad soldering. For now, let's look at the other 10 percent.

But, before we do that, I'm going to assume (and we all know what assume means) that you have stuffed the various PC boards correctly. No one wants to be called wrong, but it's so easy to insert a diode the wrong way, and one misplaced diode can prevent a project from working.

One Part Electronics, Nine Parts Common Sense

Sounds simple enough, but alas, seems most of us run into a wall when it comes to common sense and electronics. Here's a classic example a friend of mine did several years ago. He just finished assembling a new Heathkit HR-1680 receiver. When he turned it on, nothing happened. Nothing! He spent the next few days pouring over the schematics and troubleshooting guides. One day after work, I came home and found a large box sitting on my doorstep. The note said simply, "Fix the damn thing before I destroy it!"

After a few minutes on the phone with Richard, he told me what he did to try and locate the problem. The receiver was just plain dead. No nothing. No dial lights, no sound, no nothing.

After I took off the top cover, and looked inside, I instantly found the problem; no fuse in the fuse-holder! Richard had it in his head that there just had to be something wrong with the kit. There had to be a bad part someplace on a circuit board. There just had to be something wrong! The more he looked, the more his mind became focused on finding that defective part lurking deep inside the HR-1680. I installed the fuse, fired the rig up and did the alignment. The rig tuned right up and before you know it, I had CW coming out of the speaker.

To really bring this story home, Richard was so upset with himself that he left amateur radio. No matter how hard I tried to get him back into the hobby, he was through with radios and electronics.

So, let's take a look at your dead kit. First things first. Is there a fuse in the fuse-holder?

The first thing you need to do is to set back and really look over the entire project. Look for the easy fixes first. Is there power at the outlet? Is there power at the kit? How about checking to see if the batteries (if it runs on batteries) are fresh? Do you have the kit powered with the proper voltage? How about any missing plugs or antenna jumpers? Some of the older radios such as the Drake B line required a shorted plug to be inserted into the mute socket before the radio would receive.

After you have looked over the kit for the simple things, now let's look at the ever popular "loose wire" bug. Although not as popular as the missing fuse, the loose wire does show up now and then. Remember Apollo 13? A loose wire caused all kinds of nasty things to happen.

I did promise myself I would not harp about soldering, but let me say the loose wire bug is usually caused by a bad solder connection between the wire and the PC board pads. The connection looks just fine, but upon closer inspection, you'll see a ring of solder flux surrounding the wire. This solder flux is a great insulator and the connection will be open. A quick tug on the wire will cause it to be pulled from the PC board. Aha! You just found your loose wire!

Here's another example of the loose wire syndrome. It is *very* easy to crimp into the insulation of the wire and not on the bare wire. The result is an open connection. If your kit uses any type of crimp-on connectors, pay close attention to them. You really have to get down and look to be sure they are crimped to the wire and not to the plastic insulation.

Still no luck getting the kit to work? Then it's high time to start looking for a misplaced part, and the first place to look is at the resistors. It's really easy to switch out a 4.7k-ohm with a 47k-ohm resistor. Those late night kit building binges cause more problems than you can imagine. Now, it is almost impossible to check each and every resistor in a complex kit. I look at a single value and make sure that all of those values are in the right place. Let's take our 4.7k-ohm resistor. Check each and every location a 4.7k-ohm resistor is suppose to be installed. You might surprise yourself and find a 47k mixed in where it shouldn't be.

The same rule holds true for small signal diodes. It's really, really easy to switch a 1N914 with a 1N5220 Zener diode. Equally useful, but hardly interchangeable.

While you're checking, look at the small signal transistors. It's really easy to put in a PNP device in place of the required NPN. Those tiny letters used to mark transistors are hard to see! It only takes but one misplaced device to stop your kit dead in its tracks.

As you make sure you have the proper transistor in the proper location, check the pinout to be sure you have installed the device correctly. Now, if you have the bad luck to find you placed Q3 in backwards, figure on replacing it with a new device. Although it may have survived the reversed connections, desoldering and resoldering in the part usually means its demise. Those small signal transistors (such as the ever popular 2N2222) are cheap—your junk box should have several dozen to replace the bad one.

If you have followed the instructions included in the kit, and have gone over your dead kit using these

guidelines, you should have found the problem and fixed it.

But, what if you're one of those people that always has a gray cloud following you? Well if you have checked for misplaced components, loose wires, and *bad* solder joints, it's time to dig out the test gear and dive in. And that's exactly what we'll try and do next month.

Looks like we will be starting a new year, so if there is a subject that I have not touched on, and you would like to see it here in the Radio Magic column, drop me a note. You can contact me via electronic mail at one of these E-mail addresses:

CompuServe: 73357,221
Internet: 73357.222@compuserve.com
America Online: Michae1087

Of course, good ol' US Mail works too. My address is: Mike Bryce WB8VGE, 2225 Mayflower NW, Massillon, OH 44647

Let's hear from you and get your input for the next year! RF

Got any great ham related pictures for 73 and/or Radio Fun? Contact Ron Galik at 603-924-0058 for details on getting your stuff on the cover.

Upgrade . . . Don't Stop Now

by Gordon West WB6NOA

Common Sense Safety with Hand-held Transceivers

There is justifiable concern about the danger of radio frequency emissions to the human body from ham radio equipment. There have been international medical studies about the radio frequency dangers to cellular telephone users, and there continue to be ongoing questions about all of these radio waves bouncing all over the place, ultimately effecting how our bodies work.

As you read this, you are surrounded by incoming radio waves. There are strong FM signals, powerful TV signals, cordless phones in the next room, and maybe that wireless intercom on your desk is also sending out radio frequency (RF) emissions. Let's face it, unless you lock yourself up in a copper "screen room" used by technicians to isolate equipment from incoming radio waves, there is little chance of escaping common RF bombardment of our earthly souls here on earth.

It has been the undertaking of the American National Standards Institute (ANSI) to study the biological hazards of all this RF and to develop guidelines to insure we are not overexposing ourselves to dangerous amounts of RF. And while there is still much to learn about causes and effects of radio frequency signals getting into our body, there is little or no concern about the radio waves that are naturally out there in the airwaves, surrounding us day and night.

Again, don't panic—the 2 meter radio signals from your handheld are considered safe. The signals coming out of your handheld are considered "non-ionizing," which means that they are different from the type of X-rays used by your dentist. Non-ionizing 2 meter radio waves cannot strip electrons from their natural orbits, or change the orbits of electrons within atoms. This means that the atomic structure of our bodies won't change next time you key up your small 2 meter hand-held transceiver.

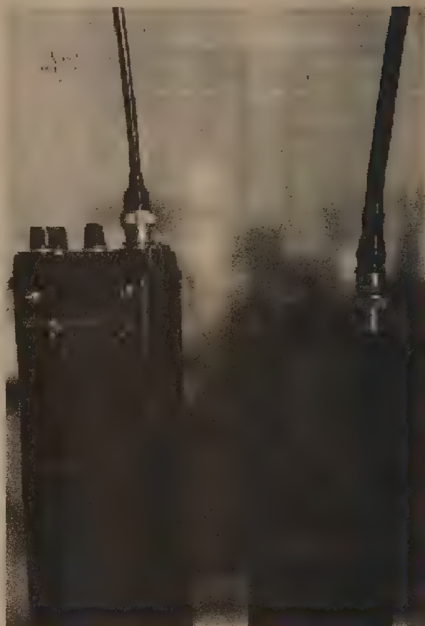
Cooking with RF

Yes, radio waves in huge concentrations can indeed change the temperature within the body, or within that hamburger or hot dog you reheat in a microwave oven. And if you are an old ham or a very old CB radio operator dating back to the 11 meter CB heyday, you can remember the strange sounding "diathermy" signals where medical personnel would beam localized RF signals to gently heat sore muscles and joints!

But let's get back to that new 2 meter transceiver that is hand held, and the antenna right there in your face. Is it dangerous? An IEEE Standards Committee C95.1-1991 studied two-way radio communications power levels, and for 2 meters, the safe power density was judged to be 1/1000 of a watt per square centimeter. This is abbreviated mW/cm^2. This figure corresponds with body resonance where the human body is more sensitive to radio waves from 100 MHz to 300 MHz.

The portable hand-held transceiver for 2 meters rarely puts out more than 5 or 6 watts from its little helical antenna. The low-power output is considered safe by experts, even though that antenna is very close to your head. Most ham radio handheld manufacturers are also locating the microphone on the HT lower down on the unit which causes you to get the little rubber antenna up and far away from your head.

There are also after-market telescopic whips that dramatically decrease the concentration of the 2 meter radio energy from the base of the antenna. And if you do a lot of transmitting with hand-held radios and their small black antennas, you may wish to invest in a speaker/microphone that would allow you to hold the handheld up and away from your head, giving you better range and less susceptibility to close-in RF fields.



Keep handheld antennas away from your face when transmitting.

If you do purchase an accessory speaker/microphone, don't get in the habit of wearing the handheld on your belt and transmitting in this position. Not good. All that RF output from the antenna is right next to your body. Why expose yourself needlessly to close-in RF fields? Also, the reception and transmission range of a handheld worn on your belt for TX/RX is attenuated by at least 20 dB because your body literally blocks the incoming and outgoing signals. Never operate your handheld with a remote mike when it's hanging on your belt.

What about Higher Power?

As a no-code Technician, new operators will, many times, increase

range by going to higher-power transceivers and base station beam antennas. Good idea—just make sure that the beam antenna isn't mounted with the front of the beam pointing directly toward someone standing within a foot. This is never a good idea. Don't stand in front of any concentrated RF field.

Most recently the 10,863-MHz X-band contest took place, and the savvy 10-GHz operators only operated their equipment from locations where no one would accidentally step in front of their parabolic dish antenna. Most low-power 10-GHz systems only put out a couple hundred milliwatts. But let's face it, these are microwaves slightly higher in frequency than your microwave oven, and why stand in front of them and bake yourself needlessly?

And anytime you see amateur radio operators playing with 10-GHz equipment with "traveling-wave tubes," stay well clear of the front part of the dish antenna. A "TWT" transmitting system has the capabilities of warming a hot dog if you were to place it on the feed horn aperture.

So stay alert to strong RF fields, and stay out of their way. Don't expose yourself to concentrated radio frequency energy at any time. Keep that hand-held 2 meter/440 antenna up high and away from your head and eyes.

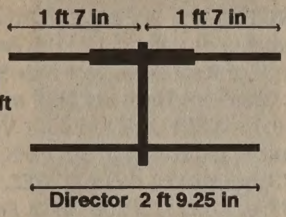
By following these simple safety tips, you should be well within the safe guidelines for RF frequency exposure. RF

Advertisers

Updates

1, 2, 4 - A Geometric Progression You'll Love

The sidebar containing the dimensions to AC3L's direct connect antenna was left out of the September 1995 issue of *Radio Fun*—here it is:



Natural Power Charge Controller

Here is some additional information for those interested in the article by KB4ZGC in the April/May 1995 issue of *Radio Fun.*

Every power source of the "natural" variety (solar, wind, and water) contains a diode in the positive output lead to prevent the battery discharging into the source when it is quiescent, or when its output voltage is lower than the battery voltage. Thus, at any time the charging voltage is *less* than the battery voltage; the source is isolated from the battery as well as the charge controller.

The storage battery being maintained by the power source is a very large and deep current sink. When the battery is at full charge, this voltage, which is dependent upon the battery type—lead/acid; lead/calcium; gel cell; nickel/alkali; nickel/cadmium; etc.—is monitored and maintained by the controller. the upper set of contacts on K2 are normally closed when the battery is at or below full charge, allowing the source to provide charging current within its capability. If the source voltage exceeds the full charge voltage of the battery, this is sensed by Q1, this point having been established during the Calibration procedure included in the article. At this time, Q1 conducts, closing the normally open contacts of K1, which applies operating voltage to K2 coil, which switches, removing the battery from the source, and illuminating D4, the LED. The normally closed contacts of K2 are opened, and K2's normally open contacts close, to accomplish this action.

Because the output of the source AND the battery positive terminal are connected together through the normally closed contacts of K2 during periods when the battery is at LESS than full charge, and because Q1 circuitry monitors the battery level (the open circuit voltage of the source, when charging the battery, falls to just a bit above the battery voltage because of the difference in capacity between the weak current source and the very great current sink represented by the battery), and this charging voltage will be *lower* than the full charge voltage set during calibration. Until the battery attains full charge, the source can continue to provide charging current, assuming the sun is shining, or the wind or water flow is moving the generator/alternator sufficiently to provide the charging current to the battery.

As "for instance," the output of a fairly large solar panel, and most available wind driven generators, is rarely over three Amperes into a short circuit, at which times the actual voltage output will be very low, much lower than the storage battery which can deliver thousands of Amperes into a short circuit. Thus, the battery actually controls the output *voltage* of the source as measured across the battery when connected to the source through the normally close contacts of K2.

The circuit monitors *both* the source *and* the battery voltage whenever the battery is at less than full charge. The circuit is designed to monitor the battery voltage until it is at full charge, when it functions to remove the source from the charging circuit. When the battery is at full charge, and the source has been removed from the charging circuit, the source then merely provides power to Q1, K1 in its collector circuit, and the coil of K2, as described earlier.

This circuit was designed to be a minimum parts, minimum cost controller, and assumes that the user has enough battery capacity that operation of the load can be continued for at least several hours without the necessity of recharging. As described under Theory of Operation in the article, for recharging to begin again after the controller has been switched out of the circuit, when the battery has been fully charged, it is necessary for the source voltage to drop below battery voltage. This is a normal occurrence and can be caused by a cloud lowering solar illumination of a solar panel, a wind shift, an eddy in the stream powering a generator. When this occurs, the source is reconnected across the battery. If the battery is below full charge, normal charging takes place. If the battery is at full charge, the controller will again be switched out of the circuit as described previously when the cloud, wind or water disturbance is eliminated. These disturbances occur often enough that this simple circuit will effectively keep a battery charged as required. I have used Nature—the variability in the natural power source—to enable a simple circuit to be essentially as effective as the sophisticated and very expensive solar controllers available commercially, and those similar ones described in the ham literature.

Communications Simplified Part I, by K2OAW, September 1995 *Radio Fun.*

There is a mix-up in captions for Figures 10, 11, and 12. The figures below show what they should have been. (Figures 1-9 are OK.)

Figure 10. Making a square wave out of sine waves.

Figure 11. Spectrum of a 1000-Hz sine wave.

Figure 12. Spectrum of a 1000-Hz square wave.

Activities Calendar

compiled by Joyce Sawtelle

Send your announcements to: Radio Fun Activities Calendar, 70 Route 202 N, Peterborough, NH 03458. We'll print as many as space allows, on a "first come-first listed" basis.

NOV 3-5

HOUSTON, TX The Gulf Coast Ham Convention, sponsored by Gulf Coast Ham Convention, Inc., will be held at the Humble Convention Center, 8233 Will Clayton Pkwy. in Humble. Indoor Swapfest, Vendor Exhibits, Major Manufacturers. Auction Fri. night. Sat. Luncheon w/guest speaker. VE Exams, Forums, Texas VHF-FM Soc. meeting. Texas DX Soc. meeting. Special hotel rate $55/night available from *Houston Airport Marriott (713) 443-2310*, and *Doubletree (713) 442-8000*, or *(800) 810-8001*. Setup Fri. 5 PM. Doors open Sat. 8 AM-5 PM; Sun. 8 AM-2 PM. Talk-in on 147.08 and 444.4. Contact *GCHC, P.O. Box 890307, Houston TX 77289-0307;* or WWW page at *http://wb6fnd.tech.uh.edu/~tdxs/gchc.html.*

NOV 5

SOUTHFIELD, MI The Oak Park ARC and the Spirit of '76 AR Klub will present their 1995 Swap and Shop at Southfield-Lathrup H.S., 19301 West 12 Mile Rd., Lathrup Village, starting at 8 AM. Vendors admitted 6 AM. Forums. VE and Commercial exams by pre-reg. only. Call *Jeff Albrecht N8WRY, (810) 642-3608*, to register. Talk-in on 146.76(-).

NOV 11

MYRTLE BEACH, SC The Grand Strand ARC will host a Hamfest 9 AM-4 PM at Myrtle Beach H.S., Central Dr., between 29th and 38th Aves. N. VE Exams at noon; contact *Les Shattuck, (803) 236-3036*. For Flea Market reservations, contact *David C. Berry KE4OOW, Grand Strand ARC, P.O. Box 2135, Myrtle Beach SC 29578-2135. Tel. (803) 248-9401.*

NOV 18-19

TAMPA, FL The Florida Gulf Coast ARC will present the 1995 ARRL State Convention, and the 20th annual Suncoast Amateur Radio/Computer Convention, at Florida Expo Park, 9 AM-5 PM Sat., and 9 AM-3 PM Sun. Call the *Ham Radio Info Line* for updated forums and more info at *(813) 531-8135*. Talk-in on 146.94(-). QSLs to all stations that contact talk-in. VE Exams both days. Mobile command posts on display. Automated bulletin station on 146.58.

NOV 19

WASHINGTON, PA Washington Amateur Communications will hold its 8th Annual Tri-State Hamfest/Computer Fair 8 AM-3 PM at Chartiers-Houston H.S. on Pine St. Talk-in on W3CYO/R 145.49(-). VE Exams. Contact *Ted Lockman WB3BZK, (412) 222-6473;* or *Russ Burhenn N3NEL, (412) 222-4037;* or *FAX (412) 258-8342. Packet: Walt Piroth N3BKW@W3CSL.#SWPA.PA.USA.NA. E-mail: Joe Stout jstout@sgi.net.* Or write: *W.A.COM, P.O. Box 1386, Washington PA 15301.*

DEC 2

MESA, AZ The Superstition ARC Hamfest will be held at Mesa Community College beginning at 7 AM. VE Exams reg. at 7:30 AM-11:30 AM. You must have original and one copy of your license and/or any applicable C.S.C.E. Photo ID required. Walk-ins only. Call *Larry Kuck, (602) 986-2298*. Talk-in 147.12(+) and 449.60 MHz. No PL tone required. Contact *Rick Checketts KA0KZB, (602) 898-9158; Edward Cole KB7RMO, 5264 East Hannibal St., Mesa AZ 85205;* or *Gary Roberts KB7VCP, (602) 461-0644.*

SPECIAL EVENT STATIONS

NOV 11-12

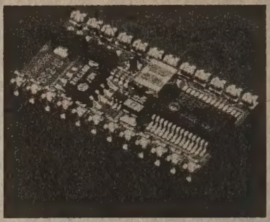
WILLOWS, CA Glenn County R A C E S and the U.S. Army Corps of Engineers will conduct a Special Event Station for emergency preparedness at Black Butte Lake, Glenn County CA. K6BIQ will be on the air from 1400 UTC on the 11th until 0500 UTC on the 12th. Freq.: 7.125(+) or -20 kHz on the hour for CW, and 7.250(+) or -20 kHz on the half hour for phone. Other frequencies will be 432.1 USB, 144.2 USB, 147.105, Simplex or Rptr., and 444.2 Simplex or Rptr. For a certificate, send SASE to *Glenn County R A C E S, P.O. Box 94, Willows CA 95988.*

NOV 25-26

PLYMOUTH, MA The Whitman ARC will commemorate Thanksgiving Day by operating WA1NPO 1400Z-2100Z each day. Freq.: 3.970, 7.270, 14.270, 18.140, 21.370, 24.970, and 28.370. A special QSL card, and a certificate with the Mayflower II in the background, are available. Please reply with an SASE to *Whitman ARC, P.O. Box 48, Whitman MA 02382.*

New Products

compiled by Staff



BASIC Stamp II Programmable Module by Parallax.

BASIC Stamp II

The Stamp II is a complete BASIC-programmable computer in a 2-pin DIP package. It has 16 I/O lines, 2K of nonvolatile memory, and a clock speed of 20-MHz.

The Stamp II's I/O lines are used to connect the Stamp to the outside world. Most I/O functions are digital, and include serial communications, pulse measurement, button input, transition counting, etc. A few functions are pseudo-analog, such as resistance measurement and PWM. The Stamp II even has functions for transmitting X-10 powerline control signals, as well as for generating accurate audio frequencies (including DTMF tones for telephone dialing).

An 8-pin EEPROM provides 2K of nonvolatile memory. This memory is used for both program and data storage. Each BASIC instruction takes 3–4 bytes of space, so the memory can store about 600 program instructions (assuming no space is taken for nonvolatile data storage).

A fast operating speed of 20 MHz yields many benefits, including fast serial I/O (up to 50K baud) and accurate pulse measurements (2 μs resolution). It also results in fast program execution (about 6000 instructions per second).

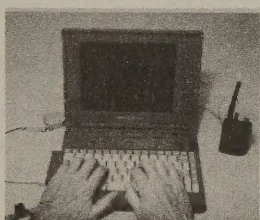
All of these features are easy to access, even for people with little experience. This is due to the Stamp II's simple "PBASIC" language. The language includes all familiar BASIC instructions, such as FOR...NEXT, IF...THEN, and GOTO, as well as special instructions for the I/O functions mentioned above.

Stamp II modules are available for $49 in single quantities. For more information please write Radio Fun, Department: New Products Info, 70 Route 202 North, Peterborough NH 03458.

more ... New Products

Electrosoft HTMORSE

Electrosoft has released software that helps no-code techs upgrade by using their HTs to learn code on-air. HTMORSE turns a laptop or tabletop PC computer into a Morse keyboard that sends Morse code from any HT by connecting the microphone jack to the computer serial port with an optional cable. (A simple schematic with Radio Shack part numbers is included in the software documentation for do-it-yourselfers who want to make their own cable.)



HTMORSE is great for talking to friends on a simplex frequency or sending code practice to hams over a repeater. Either way, learning code with HTMORSE is more effective than learning with code tapes because of the excitement generated when copying a personal on-air message.

Morse keyboard features: adjustable code speed from 5 to 100 words per minute, adjustable dot/dash ratio, ten buffers, a selectable code sidetone and a random code generator. Practice for VE exams is built-in—millions of unique conversations are simulated by drawing on a pool of common phrases.

Prices: HTMORSE $30. Optional cable: $10 (send radio manufacturer and model number). Both feature an "iron-clad" money-back guarantee. For more information please write Radio Fun, Department: New Products Info, 70 Route 202 North, Peterborough NH 03458.

An Exciting New Book

Early Radio—In Marconi's Footsteps by Peter Jensen VK2AQJ-G4GZT.

This is a fabulous 176-page, large (8-1/2" x 11"), hard-cover book. It's beautifully illustrated and tells the history of radio communications development. The author retraces Marconi's footsteps and shows his inventions as he helped develop radio from what had been just a scientific curiosity into a major world industry. Many inventors preceded him, but none had as much of an impact on the future. The book was published in Australia, however copies are available via Uncle Wayne's Bookshelf for $40.

RF Industries

RF Industries, Ltd., has completed development and is shipping NEULINK 9600, a transceiver and "new generation" data radio modem well beyond current modem technology. It has an advanced protocol which enhances digital data communications with improved reliability. NEULINK 9600 is a general purpose wireless data communications radio that can be used in a wide variety of applications. RF Industries states that it has already received orders totaling hundreds of thousands of dollars for this product, and that one of the largest orders is intending to integrate this modem transceiver into a Global Positioning Satellite (GPS) tracking and location system.

RF INDUSTRIES, LTD.

The list price is $775 without housing. For more information please write Radio Fun, Department: New Products Info, 70 Route 202 North, Peterborough NH 03458.

Old West Graphics

Old West Graphics is happy to announce the release of Photo ID Name Tags for clubs involved in ARES, RACES, SKYWARN, SSC, and NTS. Professionally produced, these tags are 2.25" wide by 4" high, heat-laminated, with a 3" strap and alligator clip for your lapel. Official reps of local groups are the only people eligible to place orders, since these are law-enforcement-recognized identification. Each tag is $5 plus 30 cents shipping and handling. Write for the Photo ID Package, which contains all necessary information and a sample.

While you're at it, request Old West Graphics' latest sign catalog and get a free surprise gift. Old West does t-shirts, custom ham radio street signs, sweatshirts, decals, banners . . . anything and anywhere you'd want your club logo or callsign. latest product is a 4" by 8" hamshack callSIGN for $5.00.

For more information please write Radio Fun, Department: New Products Info, 70 Route 202 North, Peterborough NH 03458.

Uncle Wayne's Bookshelf

BOOKS FOR BEGINNERS

TAB4354 **The Beginner's Handbook of Amateur Radio, Third Edition** *by Clay Laster W5ZPV*, 395 pages. Wonderful book for newcomers. It is basic and well illustrated. Even if you have all the other ham handbooks, you'll still find this one useful. **$22.00**

W5GWNC **Technician Class License Manual: New No-Code** *by Gordon West* This book covers everything you need to become a Technician Class Ham. Every question and answer on the examinations is found in this one book. FCC Form 610 application. **$9.95**

AR4432 **W1FB's Help for New Hams** *by Doug DeMaw W1FB* Complete for the newcomer. Put together a station and get on the air. **$10.00**

AR4920 **Introduction to Radio Frequency Design** In this practical book, the author emphasizes use of models and their application to both linear and nonlinear circuits, reviews traditional material stressing the viewpoints taken by the RF designer and illustrates subject material by numerical examples. Includes 3 1/2 inch disk for IBM PC or compatibles. **$30.00**

SOFTWARE

GGTE Morse Tutor From beginner to Extra Class. Code from 1 to over 100 words per minute. Standard or Farnsworth mode. Create your own drills. Exams conform to FCC requirements. 5 1/4" floppy for IBM PC, XT, AT, PS/2 or compatibles.

GG52/5 Morse Tutor 5.25" Disk		$19.50
GG31/2 Morse Tutor 3.5" Disk		$19.50
GGADV5 Gold Edition 5.25" Disk		$29.95
GGADV3 Gold Edition 3.5" Disk		$29.95

W5GWHO Ham Operator Education Package Software. Novice—Extra for PC's, contains both 3 1/2" and 5 1/4" disks. **$39.95**

W5GWNSW No-Code Ham Radio Software Package for PC's, contains both 3 1/2" and 5 1/4" disks. **$29.95**

Lanze Code Programs—(Available on 5 1/4" * disk.) Inexpensive complete study guide code programs for both the C64/128 Commodores and the IBM compatibles. Programs include updated FCC questions, formulas, schematic symbols, diagrams, and simulated (VE) sample test.

	IBM Part#	Commodore Part#	Price
Novice	LZIBM01	LZCOM01	$14.95
Tech	LZIBM02	N.A.**	$14.95
General	LZIBM03	N.A.**	$14.95
Advance	LZIBM04	N.A.**	$19.95
Extra	LZIBM05	LZCOM05	$19.95

* Add $2.00 for 3 1/2" disk. ** Not available

CODE TAPES

73T06 **"The Stickler"** $5.95

6+ wpm—This is the practice tape for the Novice and Technician licenses. It is comprised of one solid hour of code. Characters are sent at 13 wpm and spaced at 5 wpm.

73T13 **"Back Breaker"** $5.95

13+ wpm—Code groups again, at a brisk 13+ wpm so you'll be really at ease when you sit down in front of a steely-eyed volunteer examiner who starts sending you plain language code at only 13 per.

73T20 **"Courageous"** $5.95

20+ wpm Congratulations! Okay, the challenge of code is what's gotten you this far, so don't quit now. Go for the Extra Class license. We send the code faster than 20 per.

73T25 **"The Mind Boggler"** $5.95

25+wpm Fiendishly generated by kindly old Uncle Wayne for hams with a strong need for self punishment. Once you've conquered 25 per let Unk know if you need a 50 wpm tape.

ARRL BOOKS

AR1995 **ARRL 1995 Handbook (71st Ed.)** Features: added DSP, improved treatment of Pi and Pi-L, all new all-digital-logic, plus lots more. **$30.00**

AR1086-4 **ARRL Operating Manual (4th Ed.)** Information on how to make the best use of your station, including: interfacing home computers, OSCAR, VHF-UHF. **$18.00**

AR3657 **QRP Notebook** *by Dave DeMaw W1FB* Presents construction projects for the QRP operator. **$10.00**

AR3207 **W1FB's Design Notebook** *by Dave DeMaw W1FB* Filled with simple practical projects that can be built using readily available components and common hand tools. **$10.00**

AR0402 **Solid State Design** Good, basic information, circuit designs and applications; descriptions of receivers, transmitters, power supplies, and test equipment. **$15.00**

AR4173 **Now You're Talking! All You Need To Get Your First Ham Radio License (2nd Edition)** A complete study guide for the Technician and Novice written exam. Practical information every beginner needs is written clearly and simply and in small doses. **$19.00**

AR4971 **ARRL Repeater Directory 1995-1996** 19,000+ listings with digipeaters, bandplans, CTCSS (PL(TM)) tone chart, frequency coordinators, ARRL special service clubs, and beacon listings from 14 MHz to 24 GHz. **$7.00**

AR3398 **The DXCC Companion** *by Jim Kearman KR1S* Spells out in simple, straightforward terms what you need to be a successful DXer. **$8.00**

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